

(12) **United States Patent**
Giobbi

(10) **Patent No.:** **US 11,546,325 B2**
(45) **Date of Patent:** ***Jan. 3, 2023**

(54) **PROXIMITY-BASED SYSTEM FOR OBJECT TRACKING**

(71) Applicant: **Proxense, LLC**, Bend, OR (US)

(72) Inventor: **John J. Giobbi**, Bend, OR (US)

(73) Assignee: **Proxense, LLC**, Bend, OR (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 363 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **16/392,211**

(22) Filed: **Apr. 23, 2019**

(65) **Prior Publication Data**

US 2019/0253414 A1 Aug. 15, 2019

Related U.S. Application Data

(63) Continuation of application No. 15/077,745, filed on Mar. 22, 2016, now Pat. No. 10,313,336, which is a
(Continued)

(51) **Int. Cl.**
H04L 9/40 (2022.01)
G06K 7/10 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **H04L 63/0853** (2013.01); **G02B 6/0028** (2013.01); **G02B 6/0038** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC G02B 6/0028; G02B 6/0038; H04W 4/08; H04W 12/06; H04W 4/80; H04W 12/47;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,665,313 A 5/1972 Trent
3,739,329 A 6/1973 Lester
(Continued)

FOREIGN PATENT DOCUMENTS

EP 1536306 A1 6/2005
JP 10-049604 A 2/1998
(Continued)

OTHER PUBLICATIONS

Disclosed Anonymously (Method and Apparatus for Mobile Identity Authentication), An IP.com Prior Art Database Technical IP.com No. IPCOM000194545D., IP.com Electronic Publication Date: Mar. 29, 2010 (Year: 2010).*

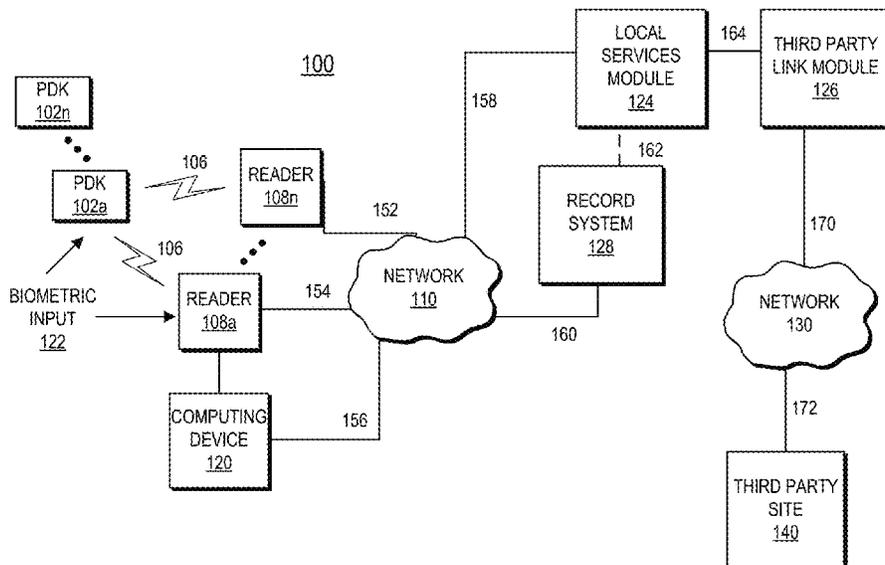
(Continued)

Primary Examiner — Yoshihisa Ishizuka
(74) *Attorney, Agent, or Firm* — Patent Law Works LLP

(57) **ABSTRACT**

A system and method provides for tracking of an object. A personal digital key (PDK) includes a profile uniquely associated with the object. A reader is configured to wirelessly communicate with the PDK. The reader receives profile information from the PDK. A tracking server is configured to communicate with the reader. The tracking server is configured to track and log location information of the PDK associated with the object. The location information is received from the reader. A computing device is configured to communicate with the reader and the tracking server, the computing device configured to display data on a display device responsive to receiving the location information from the reader.

20 Claims, 35 Drawing Sheets



Related U.S. Application Data

continuation of application No. 14/534,045, filed on Nov. 5, 2014, now Pat. No. 9,450,956, which is a continuation of application No. 13/183,420, filed on Jul. 14, 2011, now Pat. No. 9,322,974, which is a continuation of application No. 13/183,354, filed on Jul. 14, 2011, now Pat. No. 8,918,854.

(60) Provisional application No. 61/364,790, filed on Jul. 15, 2010, provisional application No. 61/364,790, filed on Jul. 15, 2010.

(51) **Int. Cl.**

- G06F 21/34** (2013.01)
- H04L 67/306** (2022.01)
- H04W 4/08** (2009.01)
- H04W 12/06** (2021.01)
- H04W 4/80** (2018.01)
- H04L 67/51** (2022.01)
- F21V 8/00** (2006.01)
- H04W 4/02** (2018.01)
- H04W 4/029** (2018.01)
- H04W 12/47** (2021.01)
- H04W 12/63** (2021.01)
- H04W 12/64** (2021.01)
- H04L 67/53** (2022.01)
- H04W 4/33** (2018.01)

(52) **U.S. Cl.**

CPC **G06F 21/34** (2013.01); **G06K 7/10366** (2013.01); **H04L 63/0861** (2013.01); **H04L 67/306** (2013.01); **H04L 67/51** (2022.05); **H04W 4/08** (2013.01); **H04W 4/80** (2018.02); **H04W 12/06** (2013.01); **H04L 67/53** (2022.05); **H04W 4/023** (2013.01); **H04W 4/029** (2018.02); **H04W 4/33** (2018.02); **H04W 12/47** (2021.01); **H04W 12/63** (2021.01); **H04W 12/64** (2021.01)

(58) **Field of Classification Search**

CPC H04W 4/33; H04W 12/63; H04W 4/029; H04W 4/023; H04L 63/0861; H04L 67/306; H04L 63/0853; H04L 67/16; H04L 67/20; G06F 21/34; G06F 21/32; G06K 7/10366

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

- 3,761,883 A 9/1973 Alvarez et al.
- 3,906,166 A 9/1975 Cooper et al.
- 4,101,873 A 7/1978 Anderson et al.
- 4,430,705 A 2/1984 Cannavino et al.
- 4,476,469 A 10/1984 Lander
- 4,598,272 A 7/1986 Cox
- 4,661,821 A 4/1987 Smith
- 4,759,060 A 7/1988 Hayashi et al.
- 4,814,742 A 3/1989 Morita et al.
- 4,871,997 A 10/1989 Adriaenssens et al.
- 4,993,068 A 2/1991 Piosenka et al.
- 5,043,702 A 8/1991 Kuo
- 5,052,049 A 9/1991 Andros et al.
- 5,187,352 A 2/1993 Blair et al.
- 5,224,164 A 6/1993 Elsner
- 5,296,641 A 3/1994 Stelzel
- 5,307,349 A 4/1994 Shloss et al.
- 5,317,572 A 5/1994 Satoh
- 5,325,285 A 6/1994 Araki
- 5,392,287 A 2/1995 Tiedemann et al.

- 5,392,433 A 2/1995 Hammersley et al.
- 5,410,588 A 4/1995 Ito
- 5,416,780 A 5/1995 Patel
- 5,422,632 A 6/1995 Bucholtz et al.
- 5,428,684 A 6/1995 Akiyama et al.
- 5,450,489 A 9/1995 Ostrover et al.
- 5,473,690 A 12/1995 Grimonprez et al.
- 5,481,265 A 1/1996 Russell
- 5,506,863 A 4/1996 Meidan et al.
- 5,517,502 A 5/1996 Bestler et al.
- 5,541,583 A 7/1996 Mandelbaum
- 5,544,321 A 8/1996 Theimer et al.
- 5,552,776 A 9/1996 Wade et al.
- 5,563,947 A 10/1996 Kikinis
- 5,589,838 A 12/1996 McEwan
- 5,594,227 A 1/1997 Deo
- 5,598,474 A 1/1997 Johnson
- 5,611,050 A 3/1997 Theimer et al.
- 5,615,277 A 3/1997 Hoffman
- 5,619,251 A 4/1997 Kuroiwa et al.
- 5,623,552 A 4/1997 Lane
- 5,629,980 A 5/1997 Stefik et al.
- 5,644,354 A 7/1997 Thompson et al.
- 5,666,412 A 9/1997 Handelman et al.
- 5,689,529 A 11/1997 Johnson
- 5,692,049 A 11/1997 Johnson et al.
- 5,719,387 A 2/1998 Fujioka
- 5,729,237 A 3/1998 Webb
- 5,760,705 A 6/1998 Glessner et al.
- 5,760,744 A 6/1998 Sauer
- 5,773,954 A 6/1998 Vanhorn
- 5,784,464 A 7/1998 Akiyama et al.
- 5,799,085 A 8/1998 Shona
- 5,821,854 A 10/1998 Dorinski et al.
- 5,825,876 A 10/1998 Peterson, Jr.
- 5,835,595 A 11/1998 Fraser et al.
- 5,838,306 A 11/1998 O'Connor et al.
- 5,854,891 A 12/1998 Postlewaite et al.
- 5,857,020 A 1/1999 Peterson, Jr.
- 5,886,634 A 3/1999 Muhme
- 5,892,825 A 4/1999 Mages et al.
- 5,892,900 A 4/1999 Ginter et al.
- 5,894,551 A 4/1999 Huggins et al.
- 5,898,880 A 4/1999 Ryu
- 5,910,776 A 6/1999 Black
- 5,917,913 A 6/1999 Wang
- 5,923,757 A 7/1999 Hocker et al.
- 5,928,327 A 7/1999 Wang et al.
- 5,942,985 A 8/1999 Chin
- 5,991,399 A 11/1999 Graunke et al.
- 5,991,749 A 11/1999 Morrill, Jr.
- 6,016,476 A 1/2000 Maes et al.
- 6,018,739 A 1/2000 McCoy et al.
- 6,025,780 A 2/2000 Bowers et al.
- 6,035,038 A 3/2000 Campings et al.
- 6,035,329 A 3/2000 Mages et al.
- 6,038,334 A 3/2000 Hamid
- 6,038,666 A 3/2000 Hsu et al.
- 6,040,786 A 3/2000 Fujioka
- 6,041,410 A 3/2000 Hsu et al.
- 6,042,006 A 3/2000 Van Tilburg et al.
- 6,045,039 A 4/2000 Stinson et al.
- 6,055,314 A 4/2000 Spies et al.
- 6,068,184 A 5/2000 Barnett
- 6,069,647 A 5/2000 Sullivan et al.
- 6,070,796 A 6/2000 Sirbu
- 6,076,164 A 6/2000 Tanaka et al.
- 6,088,450 A 7/2000 Davis et al.
- 6,088,730 A 7/2000 Kato et al.
- 6,104,290 A 8/2000 Naguleswaran
- 6,104,334 A 8/2000 Allport
- 6,110,041 A 8/2000 Walker et al.
- 6,121,544 A 9/2000 Petsinger
- 6,134,283 A 10/2000 Sands et al.
- 6,137,480 A 10/2000 Shintani
- 6,138,010 A 10/2000 Rabe et al.
- 6,148,142 A 11/2000 Anderson
- 6,148,210 A 11/2000 Elwin et al.
- 6,161,179 A 12/2000 Seidel

(56)

References Cited

U.S. PATENT DOCUMENTS

6,175,921	B1	1/2001	Rosen	6,697,944	B1	2/2004	Jones et al.
6,177,887	B1	1/2001	Jerome	6,709,333	B1	3/2004	Bradford et al.
6,185,316	B1	2/2001	Buffam	6,711,464	B1	3/2004	Yap et al.
6,189,105	B1	2/2001	Lopes	6,714,168	B2	3/2004	Berenbaum
6,209,089	B1	3/2001	Selitrennikoff et al.	6,715,246	B1	4/2004	Frecska et al.
6,219,109	B1	4/2001	Raynesford et al.	6,728,397	B2	4/2004	McNeal
6,219,439	B1	4/2001	Burger	6,737,955	B2	5/2004	Ghabra et al.
6,219,553	B1	4/2001	Panasik	6,758,394	B2	7/2004	Maskatiya et al.
6,237,848	B1	5/2001	Everett	6,771,969	B1	8/2004	Chinoy et al.
6,240,076	B1	5/2001	Kanerva et al.	6,775,655	B1	8/2004	Peinado et al.
6,247,130	B1	6/2001	Fritsch	6,785,474	B2	8/2004	Hirt et al.
6,249,869	B1	6/2001	Drupsteen et al.	6,788,640	B2	9/2004	Celeste
6,256,737	B1	7/2001	Bianco et al.	6,788,924	B1	9/2004	Knutson et al.
6,266,415	B1	7/2001	Campinos et al.	6,795,425	B1	9/2004	Raith
6,270,011	B1	8/2001	Gottfried	6,804,825	B1	10/2004	White et al.
6,279,111	B1	8/2001	Jensenworth et al.	6,806,887	B2	10/2004	Chernock et al.
6,279,146	B1	8/2001	Evans et al.	6,819,219	B1	11/2004	Bolle et al.
6,295,057	B1	9/2001	Rosin et al.	6,839,542	B2	1/2005	Sibecas et al.
6,307,471	B1	10/2001	Xydis	6,850,147	B2	2/2005	Prokoski et al.
6,325,285	B1	12/2001	Baratelli	6,853,988	B1	2/2005	Dickinson et al.
6,336,121	B1	1/2002	Kyato et al.	6,859,812	B1	2/2005	Poynor
6,336,142	B1	1/2002	Kato et al.	6,861,980	B1	3/2005	Rowitch et al.
6,343,280	B2	1/2002	Clark	6,873,975	B1	3/2005	Hatakeyama et al.
6,345,347	B1	2/2002	Biran	6,879,567	B2	4/2005	Callaway et al.
6,363,485	B1	3/2002	Adams et al.	6,879,966	B1	4/2005	Lapsley et al.
6,367,019	B1	4/2002	Ansell et al.	6,886,741	B1	5/2005	Salveson
6,369,693	B1	4/2002	Gibson	6,889,067	B2	5/2005	Willey
6,370,376	B1	4/2002	Sheath	6,891,822	B1	5/2005	Gubbi et al.
6,381,029	B1	4/2002	Tipirneni	6,892,307	B1	5/2005	Wood et al.
6,381,747	B1	4/2002	Wonfor et al.	6,930,643	B2	8/2005	Byrne et al.
6,385,596	B1	5/2002	Wiser et al.	6,947,003	B2	9/2005	Huor
6,392,664	B1	5/2002	White et al.	6,950,941	B1	9/2005	Lee et al.
6,397,387	B1	5/2002	Rosin et al.	6,957,086	B2	10/2005	Bahl et al.
6,401,059	B1	6/2002	Shen et al.	6,961,858	B2	11/2005	Fransdonk
6,411,307	B1	6/2002	Rosin et al.	6,963,270	B1	11/2005	Gallagher et al.
6,424,249	B1	7/2002	Houvener	6,963,971	B1	11/2005	Bush et al.
6,424,715	B1	7/2002	Saito	6,973,576	B2	12/2005	Giobbi
6,425,084	B1	7/2002	Rallis et al.	6,975,202	B1	12/2005	Rodriguez et al.
6,434,403	B1	8/2002	Ausems et al.	6,980,087	B2	12/2005	Zukowski
6,434,535	B1	8/2002	Kupka et al.	6,983,882	B2	1/2006	Cassone
6,446,004	B1	9/2002	Cao et al.	6,999,032	B2	2/2006	Pakray et al.
6,446,130	B1	9/2002	Grapes	7,012,503	B2	3/2006	Nielsen
6,463,534	B1	10/2002	Geiger et al.	7,020,635	B2	3/2006	Hamilton et al.
6,480,101	B1	11/2002	Kelly et al.	7,031,945	B1	4/2006	Donner
6,480,188	B1	11/2002	Horsley	7,049,963	B2	5/2006	Waterhouse et al.
6,484,182	B1	11/2002	Dunphy et al.	7,055,171	B1	5/2006	Martin et al.
6,484,260	B1	11/2002	Scott et al.	7,058,806	B2	6/2006	Smeets et al.
6,484,946	B2	11/2002	Matsumoto et al.	7,061,380	B1	6/2006	Orlando et al.
6,487,663	B1	11/2002	Jaisimha et al.	7,068,623	B1	6/2006	Barany et al.
6,490,443	B1	12/2002	Freeny, Jr.	7,072,900	B2	7/2006	Sweitzer et al.
6,510,350	B1	1/2003	Steen et al.	7,079,079	B2	7/2006	Jo et al.
6,522,253	B1	2/2003	Saltus	7,080,049	B2	7/2006	Truitt et al.
6,523,113	B1	2/2003	Wehrenberg	7,082,415	B1	7/2006	Robinson et al.
6,529,949	B1	3/2003	Getsin et al.	7,090,126	B2	8/2006	Kelly et al.
6,546,418	B2	4/2003	Schena et al.	7,090,128	B2	8/2006	Farley et al.
6,550,011	B1	4/2003	Sims, III	7,100,053	B1	8/2006	Brown et al.
6,563,465	B2	5/2003	Frecska	7,107,455	B1	9/2006	Merkin
6,563,805	B1	5/2003	Ma et al.	7,107,462	B2	9/2006	Fransdonk
6,564,380	B1	5/2003	Murphy	7,111,789	B2	9/2006	Rajasekaran et al.
6,577,238	B1	6/2003	Whitesmith et al.	7,112,138	B2	9/2006	Hedrick et al.
6,593,887	B2	7/2003	Luk et al.	7,119,659	B2	10/2006	Bonalle et al.
6,597,680	B1	7/2003	Lindskog et al.	7,123,149	B2	10/2006	Nowak et al.
6,607,136	B1	8/2003	Atsmon et al.	7,130,668	B2	10/2006	Chang et al.
6,624,752	B2	9/2003	Klitsgaard et al.	7,131,139	B1	10/2006	Meier
6,628,302	B2	9/2003	White et al.	7,137,008	B1	11/2006	Hamid et al.
6,632,992	B2	10/2003	Hasegawa	7,137,012	B1	11/2006	Kamibayashi et al.
6,633,981	B1	10/2003	Davis	7,139,914	B2	11/2006	Arnouse
6,645,077	B2	11/2003	Rowe	7,150,045	B2	12/2006	Koelle et al.
6,647,417	B1	11/2003	Hunter et al.	7,155,416	B2	12/2006	Shatford
6,657,538	B1	12/2003	Ritter	7,159,114	B1	1/2007	Zajkowski et al.
6,658,566	B1	12/2003	Hazard	7,159,765	B2	1/2007	Frerking
6,667,684	B1	12/2003	Waggamon et al.	7,167,987	B2	1/2007	Angelo
6,669,096	B1	12/2003	Saphar et al.	7,168,089	B2	1/2007	Nguyen et al.
6,671,808	B1	12/2003	Abbott et al.	7,176,797	B2	2/2007	Zai et al.
6,683,954	B1	1/2004	Searle	7,185,363	B1	2/2007	Narin et al.
				7,188,110	B1	3/2007	Ludtke et al.
				7,191,466	B1	3/2007	Hamid et al.
				7,194,438	B2	3/2007	Sovio et al.
				7,209,955	B1	4/2007	Major et al.

(56)

References Cited

U.S. PATENT DOCUMENTS

7,218,944	B2	5/2007	Cromer et al.	7,652,892	B2	1/2010	Shiu et al.
7,225,161	B2	5/2007	Lam et al.	7,676,380	B2	3/2010	Graves et al.
7,230,908	B2	6/2007	Vanderaar et al.	7,689,005	B2	3/2010	Wang et al.
7,231,068	B2	6/2007	Tibor	7,701,858	B2	4/2010	Werb et al.
7,231,451	B2	6/2007	Law et al.	7,706,896	B2	4/2010	Music et al.
7,239,226	B2	7/2007	Berardi et al.	7,711,152	B1	5/2010	Davida et al.
7,242,923	B2	7/2007	Perera et al.	7,711,586	B2	5/2010	Aggarwal et al.
7,249,177	B1	7/2007	Miller	7,715,593	B1	5/2010	Adams et al.
7,272,723	B1	9/2007	Abbott et al.	7,724,713	B2	5/2010	Del Prado Pavon et al.
7,277,737	B1	10/2007	Vollmer et al.	7,724,717	B2	5/2010	Porras et al.
7,278,025	B2	10/2007	Saito et al.	7,724,720	B2	5/2010	Korpela et al.
7,283,650	B1	10/2007	Sharma et al.	7,764,236	B2	7/2010	Hill et al.
7,295,119	B2	11/2007	Rappaport et al.	7,765,164	B1	7/2010	Robinson et al.
7,305,560	B2	12/2007	Giobbi	7,765,181	B2	7/2010	Thomas et al.
7,310,042	B2	12/2007	Seifert	7,768,960	B1	8/2010	Barratt
7,314,164	B2	1/2008	Bonalle et al.	7,773,754	B2	8/2010	Buer et al.
7,317,799	B2	1/2008	Hammersmith et al.	7,774,613	B2	8/2010	Lemke
7,319,395	B2	1/2008	Puzio et al.	7,780,082	B2	8/2010	Handa et al.
7,330,108	B2	2/2008	Thomas	7,796,551	B1	9/2010	Machiraju et al.
7,333,002	B2	2/2008	Bixler et al.	7,813,822	B1	10/2010	Hoffberg
7,333,615	B1	2/2008	Jarboe et al.	7,865,448	B2	1/2011	Pizarro
7,336,181	B2	2/2008	Nowak et al.	7,865,937	B1	1/2011	White et al.
7,336,182	B1	2/2008	Baranowski et al.	7,883,003	B2	2/2011	Giobbi et al.
7,337,326	B2	2/2008	Palmer et al.	7,883,417	B2	2/2011	Bruzzese et al.
7,341,181	B2	3/2008	Bonalle et al.	7,904,718	B2	3/2011	Giobbi et al.
7,342,503	B1	3/2008	Light et al.	7,943,868	B2	5/2011	Anders et al.
7,349,557	B2	3/2008	Tibor	7,957,536	B2	6/2011	Nolte
7,356,393	B1	4/2008	Schlatre et al.	7,961,078	B1	6/2011	Reynolds et al.
7,356,706	B2	4/2008	Scheurich	7,984,064	B2	7/2011	Fusari
7,361,919	B2	4/2008	Setlak	7,996,514	B2	8/2011	Baumert et al.
7,363,494	B2	4/2008	Brainard et al.	8,026,821	B2	9/2011	Reeder et al.
7,370,366	B2	5/2008	Lacan et al.	8,036,152	B2	10/2011	Brown et al.
7,378,939	B2	5/2008	Sengupta et al.	8,077,041	B2	12/2011	Stern et al.
7,380,202	B1	5/2008	Lindhorst et al.	8,081,215	B2	12/2011	Kuo et al.
7,382,799	B1	6/2008	Young et al.	8,082,160	B2	12/2011	Collins et al.
7,387,235	B2	6/2008	Gilbert et al.	8,089,354	B2	1/2012	Perkins
7,401,731	B1	7/2008	Pletz et al.	8,112,066	B2	2/2012	Ben Ayed
7,404,088	B2	7/2008	Giobbi	8,125,624	B2	2/2012	Jones et al.
7,408,799	B1	8/2008	Kang	8,135,624	B1	3/2012	Ramalingam et al.
7,424,134	B2	9/2008	Chou	8,171,528	B1	5/2012	Brown
7,437,330	B1	10/2008	Robinson et al.	8,193,923	B2	6/2012	Rork et al.
7,447,911	B2	11/2008	Chou et al.	8,200,980	B1	6/2012	Robinson et al.
7,448,087	B2	11/2008	Ohmori et al.	8,215,552	B1	7/2012	Rambadt
7,458,510	B1	12/2008	Zhou	8,219,129	B2	7/2012	Brown et al.
7,460,836	B2	12/2008	Smith et al.	8,248,263	B2	8/2012	Shervey et al.
7,461,444	B2	12/2008	Deaett et al.	8,258,942	B1	9/2012	Lanzone et al.
7,464,053	B1	12/2008	Pylant	8,294,554	B2	10/2012	Shoarinejad et al.
7,464,059	B1	12/2008	Robinson et al.	8,296,573	B2	10/2012	Bolle et al.
7,466,232	B2	12/2008	Neuwirth	8,307,414	B2	11/2012	Zerfos et al.
7,472,280	B2	12/2008	Giobbi	8,325,011	B2	12/2012	Butler et al.
7,512,806	B2	3/2009	Lemke	8,340,672	B2	12/2012	Brown et al.
7,525,413	B2	4/2009	Jung et al.	8,352,730	B2	1/2013	Giobbi
7,529,944	B2	5/2009	Hamid	8,373,562	B1	2/2013	Heinze et al.
7,533,809	B1	5/2009	Robinson et al.	8,387,124	B2	2/2013	Smetters et al.
7,545,312	B2	6/2009	Kiang et al.	8,390,456	B2	3/2013	Puleston et al.
7,565,329	B2	7/2009	Lapsley et al.	8,395,484	B2	3/2013	Fullerton
7,573,382	B2	8/2009	Choubey et al.	8,410,906	B1	4/2013	Dacus et al.
7,573,841	B2	8/2009	Lee et al.	8,412,949	B2	4/2013	Giobbi et al.
7,574,734	B2	8/2009	Fedronic et al.	8,421,606	B2	4/2013	Collins et al.
7,578,442	B2	8/2009	Knowles et al.	8,424,079	B2	4/2013	Adams et al.
7,583,238	B2	9/2009	Cassen et al.	8,432,262	B2	4/2013	Talty et al.
7,583,643	B2	9/2009	Smith et al.	8,433,919	B2	4/2013	Giobbi et al.
7,587,502	B2	9/2009	Crawford et al.	8,448,858	B1	5/2013	Kundu et al.
7,587,611	B2	9/2009	Johnson et al.	8,457,672	B2	6/2013	Brown et al.
7,594,611	B1	9/2009	Arrington, III	8,473,748	B2	6/2013	Sampas
7,595,765	B1	9/2009	Hirsch et al.	8,484,696	B2	7/2013	Gatto et al.
7,603,564	B2	10/2009	Adachi	8,494,576	B1	7/2013	Bye et al.
7,606,733	B2	10/2009	Shmueli et al.	8,508,336	B2	8/2013	Giobbi et al.
7,617,523	B2	11/2009	Das et al.	8,511,555	B2	8/2013	Babcock et al.
7,620,184	B2	11/2009	Marque Pucheu	8,519,823	B2	8/2013	Rinkes
7,624,073	B1	11/2009	Robinson et al.	8,522,019	B2	8/2013	Michaelis
7,624,417	B2	11/2009	Dua	8,558,699	B2	10/2013	Butler et al.
7,640,273	B2	12/2009	Wallmeier et al.	8,572,391	B2	10/2013	Golan et al.
7,644,443	B2	1/2010	Matsuyama et al.	8,577,091	B2	11/2013	Ivanov et al.
7,646,307	B2	1/2010	Plocher et al.	8,646,042	B1	2/2014	Brown
				8,659,427	B2	2/2014	Brown et al.
				8,678,273	B2	3/2014	McNeal
				8,717,346	B2	5/2014	Claessen
				8,738,925	B1	5/2014	Park et al.

(56)

References Cited

U.S. PATENT DOCUMENTS

8,799,574	B2	8/2014	Corda	2002/0015008	A1	2/2002	Kishida et al.
8,838,993	B2	9/2014	Giobbi et al.	2002/0015494	A1	2/2002	Nagai et al.
8,856,539	B2	10/2014	Weiss	2002/0019811	A1	2/2002	Lapsley et al.
8,857,716	B1	10/2014	Giobbi et al.	2002/0022455	A1	2/2002	Salokannel et al.
8,886,954	B1	11/2014	Giobbi	2002/0023032	A1	2/2002	Pearson et al.
8,907,861	B2	12/2014	Hirt	2002/0023217	A1	2/2002	Wheeler et al.
8,914,477	B2	12/2014	Gammon	2002/0026424	A1	2/2002	Akashi
8,918,854	B1	12/2014	Giobbi	2002/0037732	A1	3/2002	Gous et al.
8,931,698	B2	1/2015	Ishikawa et al.	2002/0052193	A1	5/2002	Chetty
8,979,646	B2	3/2015	Moser et al.	2002/0055908	A1	5/2002	Di Giorgio et al.
9,020,854	B2	4/2015	Giobbi	2002/0056043	A1	5/2002	Glass
9,037,140	B1	5/2015	Brown	2002/0059114	A1	5/2002	Cockrill et al.
9,042,819	B2	5/2015	Dua	2002/0062249	A1	5/2002	Iannacci
9,049,188	B1	6/2015	Brown	2002/0068605	A1	6/2002	Stanley
9,113,464	B2	8/2015	Brown et al.	2002/0069364	A1	6/2002	Dosch
9,165,233	B2	10/2015	Testanero	2002/0071559	A1	6/2002	Christensen et al.
9,189,788	B1	11/2015	Robinson et al.	2002/0073042	A1	6/2002	Maritzen et al.
9,230,399	B2	1/2016	Yacenda	2002/0076051	A1	6/2002	Nii
9,235,700	B1	1/2016	Brown	2002/0080969	A1	6/2002	Giobbi
9,251,326	B2	2/2016	Giobbi et al.	2002/0083178	A1	6/2002	Brothers
9,251,332	B2	2/2016	Giobbi	2002/0083318	A1	6/2002	Larose
9,265,043	B2	2/2016	Brown et al.	2002/0086690	A1	7/2002	Takahashi et al.
9,265,450	B1	2/2016	Giobbi	2002/0089890	A1	7/2002	Fibranz et al.
9,269,221	B2	2/2016	Brown et al.	2002/0091646	A1	7/2002	Lake et al.
9,276,914	B2	3/2016	Woodward et al.	2002/0095586	A1	7/2002	Doyle et al.
9,298,905	B1	3/2016	Giobbi	2002/0095587	A1	7/2002	Doyle et al.
9,305,312	B2	4/2016	Kountotsis et al.	2002/0097876	A1	7/2002	Harrison
9,322,974	B1	4/2016	Giobbi	2002/0098888	A1	7/2002	Rowe et al.
9,405,898	B2	8/2016	Giobbi	2002/0100798	A1	8/2002	Farrugia et al.
9,418,205	B2	8/2016	Giobbi	2002/0103027	A1	8/2002	Rowe et al.
9,450,956	B1	9/2016	Giobbi	2002/0103881	A1	8/2002	Granade et al.
9,542,542	B2	1/2017	Giobbi et al.	2002/0104006	A1	8/2002	Boate et al.
9,613,483	B2	4/2017	Giobbi	2002/0104019	A1	8/2002	Chatani et al.
9,679,289	B1	6/2017	Brown	2002/0105918	A1	8/2002	Yamada et al.
9,728,080	B1	8/2017	Giobbi et al.	2002/0108049	A1	8/2002	Xu et al.
9,807,091	B2	10/2017	Giobbi	2002/0109580	A1	8/2002	Shreve et al.
9,830,504	B2	11/2017	Masood et al.	2002/0111919	A1	8/2002	Weller et al.
9,892,250	B2	2/2018	Giobbi	2002/0112183	A1	8/2002	Baird et al.
9,898,662	B2	2/2018	Tsuda et al.	2002/0116615	A1	8/2002	Nguyen et al.
9,904,816	B1	2/2018	Giobbi et al.	2002/0124251	A1	9/2002	Hunter et al.
9,990,628	B2	6/2018	Giobbi	2002/0128017	A1	9/2002	Virtanen
10,026,253	B2	7/2018	Giobbi	2002/0129262	A1	9/2002	Kutaragi et al.
10,073,960	B1	9/2018	Brown	2002/0138438	A1	9/2002	Bardwell
10,110,385	B1	10/2018	Rush et al.	2002/0138767	A1	9/2002	Hamid et al.
10,171,460	B2	1/2019	Giobbi	2002/0140542	A1	10/2002	Prokoski et al.
10,217,339	B1	2/2019	Giobbi	2002/0141586	A1	10/2002	Margalit et al.
10,229,294	B1	3/2019	Giobbi et al.	2002/0143623	A1	10/2002	Dayley
10,313,336	B2	6/2019	Giobbi	2002/0143655	A1	10/2002	Elston et al.
10,334,541	B1	6/2019	Brown	2002/0144116	A1	10/2002	Giobbi
10,374,795	B1	8/2019	Giobbi et al.	2002/0144117	A1	10/2002	Faigle
10,383,112	B2	8/2019	Brown et al.	2002/0147653	A1	10/2002	Shmueli et al.
10,403,128	B2	9/2019	Giobbi et al.	2002/0148892	A1	10/2002	Bardwell
10,437,976	B2	10/2019	Giobbi	2002/0150282	A1	10/2002	Kinsella
10,455,533	B2	10/2019	Brown	2002/0152391	A1	10/2002	Willins et al.
10,469,456	B1	11/2019	Giobbi	2002/0153996	A1	10/2002	Chan et al.
10,698,989	B2	6/2020	Giobbi	2002/0158121	A1	10/2002	Stanford-Clark
10,764,044	B1	9/2020	Giobbi et al.	2002/0158750	A1	10/2002	Almalik
10,769,939	B2	9/2020	Brown et al.	2002/0158765	A1	10/2002	Pape et al.
10,817,964	B2	10/2020	Guillama et al.	2002/0160820	A1	10/2002	Winkler
10,909,229	B2	2/2021	Giobbi	2002/0174348	A1	11/2002	Ting
10,943,471	B1	3/2021	Giobbi et al.	2002/0177460	A1	11/2002	Beasley et al.
11,212,797	B2	12/2021	Brown et al.	2002/0178063	A1	11/2002	Gravelle et al.
11,219,022	B2	1/2022	Brown et al.	2002/0184208	A1	12/2002	Kato
2001/0000535	A1	4/2001	Lapsley et al.	2002/0187746	A1	12/2002	Cheng et al.
2001/0021950	A1	9/2001	Hawley et al.	2002/0191816	A1	12/2002	Maritzen et al.
2001/0024428	A1	9/2001	Onouchi	2002/0196963	A1	12/2002	Bardwell
2001/0026619	A1	10/2001	Howard et al.	2002/0199120	A1	12/2002	Schmidt
2001/0027121	A1	10/2001	Boesen	2003/0022701	A1	1/2003	Gupta
2001/0027439	A1	10/2001	Holtzman et al.	2003/0034877	A1	2/2003	Miller et al.
2001/0044337	A1	11/2001	Rowe et al.	2003/0036416	A1	2/2003	Pattabiraman et al.
2002/0004783	A1	1/2002	Paltenghe et al.	2003/0036425	A1	2/2003	Kaminkow et al.
2002/0007456	A1	1/2002	Peinado et al.	2003/0046228	A1	3/2003	Berney
2002/0010679	A1	1/2002	Felsner	2003/0046237	A1	3/2003	Uberti
2002/0013772	A1	1/2002	Peinado	2003/0046552	A1	3/2003	Hamid
2002/0014954	A1	2/2002	Fitzgibbon et al.	2003/0048174	A1	3/2003	Stevens et al.
				2003/0051173	A1	3/2003	Krueger
				2003/0054868	A1	3/2003	Paulsen et al.
				2003/0054881	A1	3/2003	Hedrick et al.
				2003/0055689	A1	3/2003	Block et al.

(56)

References Cited

U.S. PATENT DOCUMENTS

2003/0055792	A1	3/2003	Kinoshita et al.	2004/0137912	A1	7/2004	Lin
2003/0061172	A1	3/2003	Robinson	2004/0153649	A1	8/2004	Rhoads et al.
2003/0063619	A1	4/2003	Montano et al.	2004/0158746	A1	8/2004	Hu et al.
2003/0079133	A1	4/2003	Breiter et al.	2004/0166875	A1	8/2004	Jenkins et al.
2003/0087601	A1	5/2003	Agam et al.	2004/0167465	A1	8/2004	Mihai et al.
2003/0088441	A1	5/2003	McNerney	2004/0181695	A1	9/2004	Walker
2003/0105719	A1	6/2003	Berger et al.	2004/0193925	A1	9/2004	Safriel
2003/0109274	A1	6/2003	Budka et al.	2004/0194133	A1	9/2004	Ikeda et al.
2003/0115351	A1	6/2003	Giobbi	2004/0201755	A1	10/2004	Norskog
2003/0115474	A1	6/2003	Khan et al.	2004/0203566	A1	10/2004	Leung
2003/0117969	A1	6/2003	Koo et al.	2004/0203923	A1	10/2004	Mullen
2003/0117980	A1	6/2003	Kim et al.	2004/0208139	A1	10/2004	Iwamura
2003/0120934	A1	6/2003	Ortiz	2004/0209690	A1	10/2004	Bruzzese et al.
2003/0127511	A1	7/2003	Kelly et al.	2004/0209692	A1	10/2004	Schober et al.
2003/0128866	A1	7/2003	McNeal	2004/0214582	A1	10/2004	Lan et al.
2003/0137404	A1	7/2003	Bonneau et al.	2004/0215615	A1	10/2004	Larsson et al.
2003/0139190	A1	7/2003	Steelberg et al.	2004/0217859	A1	11/2004	Pucci et al.
2003/0142041	A1	7/2003	Barlow et al.	2004/0218581	A1	11/2004	Cattaneo
2003/0146835	A1	8/2003	Carter	2004/0222877	A1	11/2004	Teramura et al.
2003/0149744	A1	8/2003	Bierre et al.	2004/0230488	A1	11/2004	Beenau et al.
2003/0156742	A1	8/2003	Witt et al.	2004/0230809	A1	11/2004	Lowensohn et al.
2003/0159040	A1	8/2003	Hashimoto et al.	2004/0234117	A1	11/2004	Tibor
2003/0163388	A1	8/2003	Beane	2004/0243519	A1	12/2004	Perttila et al.
2003/0167207	A1	9/2003	Berardi et al.	2004/0246103	A1	12/2004	Zukowski
2003/0169697	A1	9/2003	Suzuki et al.	2004/0246950	A1	12/2004	Parker et al.
2003/0172028	A1	9/2003	Abell et al.	2004/0250074	A1	12/2004	Kilian-Kehr
2003/0172037	A1	9/2003	Jung et al.	2004/0252012	A1	12/2004	Beenau et al.
2003/0174839	A1	9/2003	Yamagata et al.	2004/0252659	A1	12/2004	Yun et al.
2003/0176218	A1	9/2003	Lemay et al.	2004/0253996	A1	12/2004	Chen et al.
2003/0177102	A1	9/2003	Robinson	2004/0254837	A1	12/2004	Roshkoff
2003/0186739	A1	10/2003	Paulsen et al.	2004/0255139	A1	12/2004	Giobbi
2003/0195842	A1	10/2003	Reece	2004/0255145	A1	12/2004	Chow
2003/0196084	A1	10/2003	Okereke et al.	2005/0001028	A1	1/2005	Zuili
2003/0199267	A1	10/2003	Iwasa et al.	2005/0002028	A1	1/2005	Kasapi et al.
2003/0204526	A1	10/2003	Salehi-Had	2005/0005136	A1	1/2005	Chen et al.
2003/0204721	A1	10/2003	Barrus et al.	2005/0006452	A1	1/2005	Aupperle et al.
2003/0213840	A1	11/2003	Livingston et al.	2005/0009517	A1	1/2005	Maes
2003/0223394	A1	12/2003	Parantainen et al.	2005/0020322	A1	1/2005	Ruuska et al.
2003/0225703	A1	12/2003	Angel	2005/0021561	A1	1/2005	Noonan
2003/0226031	A1	12/2003	Proudlar et al.	2005/0025093	A1	2/2005	Yun et al.
2003/0233458	A1	12/2003	Kwon et al.	2005/0028168	A1	2/2005	Marcan
2004/0002347	A1	1/2004	Hocter et al.	2005/0035897	A1	2/2005	Perl et al.
2004/0015403	A1	1/2004	Moskowitz et al.	2005/0039027	A1	2/2005	Shapiro
2004/0022384	A1	2/2004	Flores et al.	2005/0040961	A1	2/2005	Tuttle
2004/0029620	A1	2/2004	Karaoguz	2005/0044372	A1	2/2005	Aull et al.
2004/0029635	A1	2/2004	Giobbi	2005/0044387	A1	2/2005	Ozolins
2004/0030764	A1	2/2004	Birk et al.	2005/0047386	A1	3/2005	Yi
2004/0030894	A1	2/2004	Labrou et al.	2005/0049013	A1	3/2005	Chang et al.
2004/0035644	A1	2/2004	Ford et al.	2005/0050208	A1	3/2005	Chatani
2004/0039909	A1	2/2004	Cheng	2005/0050324	A1	3/2005	Corbett et al.
2004/0044627	A1	3/2004	Russell et al.	2005/0054431	A1	3/2005	Walker et al.
2004/0048570	A1	3/2004	Oba et al.	2005/0055242	A1	3/2005	Bello et al.
2004/0048609	A1	3/2004	Kosaka	2005/0055244	A1	3/2005	Mullan et al.
2004/0059682	A1	3/2004	Hasumi et al.	2005/0058292	A1	3/2005	Diorio et al.
2004/0059912	A1	3/2004	Zizzi	2005/0074126	A1	4/2005	Stanko
2004/0064728	A1	4/2004	Scheurich	2005/0076242	A1	4/2005	Breuer
2004/0068656	A1	4/2004	Lu	2005/0081040	A1	4/2005	Johnson et al.
2004/0073792	A1	4/2004	Noble et al.	2005/0084137	A1	4/2005	Kim et al.
2004/0081127	A1	4/2004	Gardner et al.	2005/0086115	A1	4/2005	Pearson
2004/0082385	A1	4/2004	Silva et al.	2005/0086501	A1	4/2005	Woo et al.
2004/0088558	A1	5/2004	Candelore	2005/0086515	A1	4/2005	Paris
2004/0090345	A1	5/2004	Hitt	2005/0089000	A1	4/2005	Bae et al.
2004/0098597	A1	5/2004	Giobbi	2005/0090200	A1	4/2005	Karaoguz et al.
2004/0114563	A1	6/2004	Shvodian	2005/0091338	A1	4/2005	De La Huerga
2004/0117644	A1	6/2004	Colvin	2005/0091553	A1	4/2005	Chien et al.
2004/0123106	A1	6/2004	D'Angelo et al.	2005/0094657	A1	5/2005	Sung et al.
2004/0123127	A1	6/2004	Teicher et al.	2005/0096053	A1	5/2005	Liu et al.
2004/0127277	A1	7/2004	Walker et al.	2005/0097037	A1	5/2005	Tibor
2004/0128162	A1	7/2004	Schlotterbeck et al.	2005/0105600	A1	5/2005	Culum et al.
2004/0128389	A1	7/2004	Kopchik	2005/0105734	A1	5/2005	Buer et al.
2004/0128500	A1	7/2004	Cihula et al.	2005/0108164	A1	5/2005	Salafi et al.
2004/0128508	A1	7/2004	Wheeler et al.	2005/0109836	A1	5/2005	Ben-Aissa
2004/0128519	A1	7/2004	Klinger et al.	2005/0109841	A1	5/2005	Ryan et al.
2004/0129787	A1	7/2004	Saito et al.	2005/0113070	A1	5/2005	Okabe
2004/0132432	A1	7/2004	Moores et al.	2005/0114149	A1	5/2005	Rodriguez et al.
				2005/0114150	A1	5/2005	Franklin
				2005/0116020	A1	6/2005	Smolucha et al.
				2005/0117530	A1	6/2005	Abraham et al.
				2005/0119979	A1	6/2005	Murashita et al.

(56)

References Cited

U.S. PATENT DOCUMENTS

2005/0124294	A1	6/2005	Menzo	2006/0074713	A1	4/2006	Conry et al.
2005/0125258	A1	6/2005	Yellin et al.	2006/0076401	A1	4/2006	Frerking
2005/0137827	A1	6/2005	Takamiya	2006/0078176	A1	4/2006	Abiko et al.
2005/0137977	A1	6/2005	Wankmueller	2006/0087407	A1	4/2006	Stewart et al.
2005/0138390	A1	6/2005	Adams et al.	2006/0089138	A1	4/2006	Smith et al.
2005/0138576	A1	6/2005	Baumert et al.	2006/0097949	A1	5/2006	Luebke et al.
2005/0139656	A1	6/2005	Arnouse	2006/0110012	A1	5/2006	Ritter
2005/0141451	A1	6/2005	Yoon et al.	2006/0111955	A1	5/2006	Winter et al.
2005/0152394	A1	7/2005	Cho	2006/0113381	A1	6/2006	Hochstein et al.
2005/0154897	A1	7/2005	Holloway et al.	2006/0116935	A1	6/2006	Evans
2005/0161503	A1	7/2005	Remery et al.	2006/0117013	A1	6/2006	Wada
2005/0165684	A1	7/2005	Jensen et al.	2006/0120287	A1	6/2006	Foti et al.
2005/0166063	A1	7/2005	Huang	2006/0129838	A1	6/2006	Chen et al.
2005/0167482	A1	8/2005	Ramachandran et al.	2006/0136728	A1	6/2006	Gentry et al.
2005/0169292	A1	8/2005	Young	2006/0136742	A1	6/2006	Giobbi
2005/0177716	A1	8/2005	Ginter et al.	2006/0143441	A1	6/2006	Giobbi
2005/0180385	A1	8/2005	Jeong et al.	2006/0144943	A1	7/2006	Kim
2005/0182661	A1	8/2005	Allard et al.	2006/0156027	A1	7/2006	Blake
2005/0182975	A1	8/2005	Guo et al.	2006/0158308	A1	7/2006	McMullen et al.
2005/0187792	A1	8/2005	Harper	2006/0163349	A1	7/2006	Neugebauer
2005/0192748	A1	9/2005	Andric et al.	2006/0165060	A1	7/2006	Dua
2005/0195975	A1	9/2005	Kawakita	2006/0169771	A1	8/2006	Brookner
2005/0200453	A1	9/2005	Turner et al.	2006/0170530	A1	8/2006	Nwosu et al.
2005/0201389	A1	9/2005	Shimanuki et al.	2006/0170565	A1	8/2006	Husak et al.
2005/0203682	A1	9/2005	Omino et al.	2006/0172700	A1	8/2006	Wu
2005/0203844	A1	9/2005	Ferguson et al.	2006/0173846	A1	8/2006	Omae et al.
2005/0210270	A1	9/2005	Rohatgi et al.	2006/0173991	A1	8/2006	Piikivi
2005/0212657	A1	9/2005	Simon	2006/0183426	A1	8/2006	Graves et al.
2005/0215233	A1	9/2005	Perera et al.	2006/0183462	A1	8/2006	Kolehmainen
2005/0216313	A1	9/2005	Claud et al.	2006/0184795	A1	8/2006	Doradla et al.
2005/0216639	A1	9/2005	Sparer et al.	2006/0185005	A1	8/2006	Graves et al.
2005/0218215	A1	10/2005	Lauden	2006/0187029	A1	8/2006	Thomas
2005/0220046	A1	10/2005	Falck et al.	2006/0190348	A1	8/2006	Ofer et al.
2005/0221869	A1	10/2005	Liu et al.	2006/0190413	A1	8/2006	Harper
2005/0229007	A1	10/2005	Bolle et al.	2006/0194598	A1	8/2006	Kim et al.
2005/0229240	A1	10/2005	Nanba	2006/0195576	A1	8/2006	Rinne et al.
2005/0231328	A1	10/2005	Castle et al.	2006/0198337	A1	9/2006	Hoang et al.
2005/0242921	A1	11/2005	Zimmerman et al.	2006/0200467	A1	9/2006	Ohmori et al.
2005/0243787	A1	11/2005	Hong et al.	2006/0205408	A1	9/2006	Nakagawa et al.
2005/0249385	A1	11/2005	Kondo et al.	2006/0208066	A1	9/2006	Finn et al.
2005/0251688	A1	11/2005	Nanavati et al.	2006/0208853	A1	9/2006	Kung et al.
2005/0253683	A1	11/2005	Lowe	2006/0226950	A1	10/2006	Kanou et al.
2005/0256878	A1	11/2005	Brown et al.	2006/0229909	A1	10/2006	Kaila et al.
2005/0257102	A1	11/2005	Moyer et al.	2006/0236373	A1	10/2006	Graves et al.
2005/0264416	A1	12/2005	Maurer	2006/0237528	A1	10/2006	Bishop et al.
2005/0268111	A1	12/2005	Markham	2006/0238305	A1	10/2006	Loving et al.
2005/0269401	A1	12/2005	Spitzer et al.	2006/0268891	A1	11/2006	Heidari-Bateni et al.
2005/0272403	A1	12/2005	Ryu et al.	2006/0273176	A1	12/2006	Audebert et al.
2005/0277385	A1	12/2005	Daum	2006/0274711	A1	12/2006	Nelson et al.
2005/0281215	A1	12/2005	Budampati et al.	2006/0279412	A1	12/2006	Holland et al.
2005/0281320	A1	12/2005	Neugebauer	2006/0286969	A1	12/2006	Talmor et al.
2005/0282558	A1	12/2005	Choi et al.	2006/0288095	A1	12/2006	Torok et al.
2005/0284932	A1	12/2005	Sukeda et al.	2006/0288233	A1	12/2006	Kozlay
2005/0287985	A1	12/2005	Balfanz et al.	2006/0290473	A1	12/2006	Mahasenan et al.
2005/0288015	A1	12/2005	Azizi et al.	2006/0290580	A1	12/2006	Noro et al.
2005/0288069	A1	12/2005	Arunan et al.	2006/0292986	A1	12/2006	Bitran et al.
2005/0289473	A1	12/2005	Gustafson et al.	2006/0293925	A1	12/2006	Flom
2006/0001525	A1	1/2006	Nitzan et al.	2006/0294388	A1	12/2006	Abraham et al.
2006/0009216	A1	1/2006	Welnick et al.	2007/0003111	A1	1/2007	Awatsu et al.
2006/0014430	A1	1/2006	Liang et al.	2007/0005403	A1	1/2007	Kennedy et al.
2006/0022042	A1	2/2006	Smets et al.	2007/0007331	A1	1/2007	Jasper et al.
2006/0022046	A1	2/2006	Iwamura	2007/0008070	A1	1/2007	Friedrich
2006/0022800	A1	2/2006	Krishna et al.	2007/0008916	A1	1/2007	Haugli et al.
2006/0025180	A1	2/2006	Rajkotia et al.	2007/0011724	A1	1/2007	Gonzalez et al.
2006/0026673	A1	2/2006	Tsuchida	2007/0016800	A1	1/2007	Spottswood et al.
2006/0030279	A1	2/2006	Leabman	2007/0019845	A1	1/2007	Kato
2006/0030353	A1	2/2006	Jun	2007/0029381	A1	2/2007	Braiman
2006/0034250	A1	2/2006	Kim et al.	2007/0032225	A1	2/2007	Konicek et al.
2006/0041746	A1	2/2006	Kirkup et al.	2007/0032288	A1	2/2007	Nelson et al.
2006/0046664	A1	3/2006	Paradiso et al.	2007/0033072	A1	2/2007	Bildirici
2006/0058102	A1	3/2006	Nguyen et al.	2007/0033150	A1	2/2007	Nwosu
2006/0063575	A1	3/2006	Gatto et al.	2007/0036396	A1	2/2007	Sugita et al.
2006/0064605	A1	3/2006	Giobbi	2007/0038751	A1	2/2007	Jorgensen
2006/0069814	A1	3/2006	Abraham et al.	2007/0043594	A1	2/2007	Lavergne
2006/0072586	A1	4/2006	Callaway et al.	2007/0050259	A1	3/2007	Wesley
				2007/0050398	A1	3/2007	Mochizuki
				2007/0050845	A1	3/2007	Das et al.
				2007/0051794	A1	3/2007	Glanz et al.
				2007/0051798	A1	3/2007	Kawai et al.

(56)

References Cited

U.S. PATENT DOCUMENTS

2007/0055630	A1	3/2007	Gauthier et al.	2008/0019578	A1	1/2008	Saito et al.
2007/0060095	A1	3/2007	Subrahmanya et al.	2008/0028227	A1	1/2008	Sakurai
2007/0060319	A1	3/2007	Block et al.	2008/0028453	A1	1/2008	Nguyen et al.
2007/0064742	A1	3/2007	Shvodian	2008/0040609	A1	2/2008	Giobbi
2007/0069852	A1	3/2007	Mo et al.	2008/0046366	A1	2/2008	Bemmel et al.
2007/0070040	A1	3/2007	Chen et al.	2008/0046715	A1	2/2008	Balazs et al.
2007/0072636	A1	3/2007	Worfolk et al.	2008/0049700	A1	2/2008	Shah et al.
2007/0073553	A1	3/2007	Flinn et al.	2008/0061941	A1	3/2008	Fischer et al.
2007/0084523	A1	4/2007	McLean et al.	2008/0071577	A1	3/2008	Highley
2007/0084913	A1	4/2007	Weston	2008/0072063	A1	3/2008	Takahashi et al.
2007/0087682	A1	4/2007	DaCosta	2008/0088475	A1	4/2008	Martin
2007/0087834	A1	4/2007	Moser et al.	2008/0090548	A1	4/2008	Ramalingam
2007/0100507	A1	5/2007	Simon	2008/0095359	A1	4/2008	Schreyer et al.
2007/0100939	A1	5/2007	Bagley et al.	2008/0107089	A1	5/2008	Larsson et al.
2007/0109117	A1	5/2007	Heitzmann et al.	2008/0109895	A1	5/2008	Janevski
2007/0112676	A1	5/2007	Kontio et al.	2008/0111752	A1	5/2008	Lindackers et al.
2007/0118891	A1	5/2007	Buer	2008/0127176	A1	5/2008	Lee et al.
2007/0120643	A1	5/2007	Lee	2008/0129450	A1	6/2008	Riegebauer
2007/0132586	A1	6/2007	Plocher et al.	2008/0129463	A1	6/2008	Tuttle
2007/0133478	A1	6/2007	Armbruster et al.	2008/0148351	A1	6/2008	Bhatia et al.
2007/0136407	A1	6/2007	Rudelic	2008/0149705	A1	6/2008	Giobbi et al.
2007/0142032	A1	6/2007	Balsillie	2008/0150678	A1	6/2008	Giobbi et al.
2007/0147332	A1	6/2007	Lappetelainen et al.	2008/0156866	A1	7/2008	McNeal
2007/0152826	A1	7/2007	August et al.	2008/0164997	A1	7/2008	Aritsuka et al.
2007/0156850	A1	7/2007	Corrion	2008/0169909	A1	7/2008	Park et al.
2007/0157249	A1	7/2007	Cordray et al.	2008/0186166	A1	8/2008	Zhou et al.
2007/0158411	A1	7/2007	Krieg, Jr.	2008/0188308	A1	8/2008	Shepherd et al.
2007/0159301	A1	7/2007	Hirt et al.	2008/0195863	A1	8/2008	Kennedy
2007/0159994	A1	7/2007	Brown et al.	2008/0201768	A1	8/2008	Koo et al.
2007/0164847	A1	7/2007	Crawford et al.	2008/0203107	A1	8/2008	Conley et al.
2007/0169121	A1	7/2007	Hunt et al.	2008/0208016	A1	8/2008	Hughes et al.
2007/0174809	A1	7/2007	Brown et al.	2008/0209571	A1	8/2008	Bhaskar et al.
2007/0176756	A1	8/2007	Friedrich	2008/0218416	A1	9/2008	Handy et al.
2007/0176778	A1	8/2007	Ando et al.	2008/0222701	A1	9/2008	Saaranen et al.
2007/0180047	A1	8/2007	Dong et al.	2008/0223918	A1	9/2008	Williams et al.
2007/0187266	A1	8/2007	Porter et al.	2008/0228524	A1	9/2008	Brown
2007/0192601	A1	8/2007	Spain et al.	2008/0235144	A1	9/2008	Phillips
2007/0194882	A1	8/2007	Yokota et al.	2008/0238625	A1	10/2008	Rofougaran et al.
2007/0198436	A1	8/2007	Weiss	2008/0250388	A1	10/2008	Meyer et al.
2007/0204078	A1	8/2007	Boccon-Gibod et al.	2008/0251579	A1	10/2008	Larsen
2007/0205860	A1	9/2007	Jones et al.	2008/0278325	A1	11/2008	Zimman et al.
2007/0205861	A1	9/2007	Nair et al.	2008/0289030	A1	11/2008	Poplett
2007/0207750	A1	9/2007	Brown et al.	2008/0289032	A1	11/2008	Aoki et al.
2007/0213048	A1	9/2007	Trauberg	2008/0303637	A1	12/2008	Gelbman et al.
2007/0214492	A1	9/2007	Gopi et al.	2008/0313728	A1	12/2008	Pandurangi et al.
2007/0218921	A1	9/2007	Lee et al.	2008/0314971	A1	12/2008	Faith et al.
2007/0219926	A1	9/2007	Korn	2008/0316045	A1	12/2008	Sriharjo et al.
2007/0220272	A1	9/2007	Campisi et al.	2009/0002134	A1	1/2009	McAllister
2007/0229268	A1	10/2007	Swan et al.	2009/0013191	A1	1/2009	Popowski
2007/0245157	A1	10/2007	Giobbi et al.	2009/0016573	A1	1/2009	McAfee et al.
2007/0245158	A1	10/2007	Giobbi et al.	2009/0024584	A1	1/2009	Dharap et al.
2007/0247366	A1	10/2007	Smith et al.	2009/0033464	A1	2/2009	Friedrich
2007/0258626	A1	11/2007	Reiner	2009/0033485	A1	2/2009	Naeve et al.
2007/0260883	A1	11/2007	Giobbi et al.	2009/0036164	A1	2/2009	Rowley
2007/0260888	A1	11/2007	Giobbi et al.	2009/0041309	A1	2/2009	Kim et al.
2007/0266257	A1	11/2007	Camaisa et al.	2009/0045916	A1	2/2009	Nitzan et al.
2007/0268862	A1	11/2007	Singh et al.	2009/0052389	A1	2/2009	Qin et al.
2007/0271194	A1	11/2007	Walker et al.	2009/0070146	A1	3/2009	Haider et al.
2007/0271433	A1	11/2007	Takemura	2009/0076849	A1	3/2009	Diller
2007/0277044	A1	11/2007	Graf et al.	2009/0081996	A1	3/2009	Duggal et al.
2007/0280509	A1	12/2007	Owen et al.	2009/0096580	A1	4/2009	Paananen
2007/0285212	A1	12/2007	Rotzoll	2009/0121890	A1	5/2009	Brown et al.
2007/0285238	A1	12/2007	Batra	2009/0125401	A1	5/2009	Beenau et al.
2007/0288263	A1	12/2007	Rodgers	2009/0140045	A1	6/2009	Evans
2007/0288752	A1	12/2007	Chan	2009/0157512	A1	6/2009	King
2007/0293155	A1	12/2007	Liao et al.	2009/0165123	A1	6/2009	Giobbi
2007/0294755	A1	12/2007	Dadhia et al.	2009/0176566	A1	7/2009	Kelly
2007/0296544	A1	12/2007	Beenau et al.	2009/0177495	A1	7/2009	Abousy et al.
2008/0001783	A1	1/2008	Cargonja et al.	2009/0195461	A1	8/2009	Hirt
2008/0005432	A1	1/2008	Kagawa	2009/0199206	A1	8/2009	Finkenzeller et al.
2008/0008359	A1	1/2008	Beenau et al.	2009/0206992	A1	8/2009	Giobbi et al.
2008/0011842	A1	1/2008	Curry et al.	2009/0232362	A1	9/2009	Otsubo et al.
2008/0012685	A1	1/2008	Friedrich et al.	2009/0237245	A1	9/2009	Brinton et al.
2008/0012767	A1	1/2008	Caliri et al.	2009/0237253	A1	9/2009	Neuwirth
2008/0016004	A1	1/2008	Kurasaki et al.	2009/0239667	A1	9/2009	Rowe et al.
				2009/0253516	A1	10/2009	Hartmann et al.
				2009/0254448	A1	10/2009	Giobbi
				2009/0254971	A1	10/2009	Herz et al.
				2009/0264712	A1	10/2009	Baldus et al.

(56)

References Cited

U.S. PATENT DOCUMENTS

- 2009/0310514 A1 12/2009 Jeon et al.
 2009/0313689 A1 12/2009 Nystroem et al.
 2009/0319788 A1 12/2009 Zick et al.
 2009/0320118 A1 12/2009 Mueller et al.
 2009/0322510 A1 12/2009 Berger et al.
 2009/0328182 A1 12/2009 Malakapalli et al.
 2010/0005526 A1 1/2010 Tsuji et al.
 2010/0007498 A1 1/2010 Jackson
 2010/0022308 A1 1/2010 Hartmann et al.
 2010/0023074 A1 1/2010 Powers et al.
 2010/0037255 A1 2/2010 Sheehan et al.
 2010/0062743 A1 3/2010 Jonsson
 2010/0077214 A1 3/2010 Jogand-Coulomb et al.
 2010/0117794 A1 5/2010 Adams et al.
 2010/0134257 A1 6/2010 Puleston et al.
 2010/0169442 A1 7/2010 Liu et al.
 2010/0169964 A1 7/2010 Liu et al.
 2010/0172567 A1 7/2010 Prokoski
 2010/0174911 A1 7/2010 Isshiki
 2010/0188226 A1 7/2010 Seder et al.
 2010/0214100 A1 8/2010 Page
 2010/0277283 A1 11/2010 Burkart et al.
 2010/0277286 A1 11/2010 Burkart et al.
 2010/0291896 A1 11/2010 Corda
 2010/0305843 A1 12/2010 Yan et al.
 2010/0328033 A1 12/2010 Kamei
 2011/0072034 A1 3/2011 Sly et al.
 2011/0072132 A1 3/2011 Shafer et al.
 2011/0082735 A1 4/2011 Kannan et al.
 2011/0085287 A1 4/2011 Ebrom et al.
 2011/0091136 A1 4/2011 Danch et al.
 2011/0116358 A9 5/2011 Li et al.
 2011/0126188 A1 5/2011 Bernstein et al.
 2011/0221568 A1 9/2011 Giobbi
 2011/0227740 A1 9/2011 Wohltjen
 2011/0238517 A1 9/2011 Ramalingam et al.
 2011/0246790 A1 10/2011 Koh et al.
 2011/0266348 A1 11/2011 Denniston, Jr.
 2011/0307599 A1 12/2011 Saretto et al.
 2012/0028609 A1 2/2012 Hruska
 2012/0030006 A1 2/2012 Yoder et al.
 2012/0069776 A1 3/2012 Caldwell et al.
 2012/0086571 A1 4/2012 Scalisi et al.
 2012/0182123 A1 7/2012 Butler et al.
 2012/0212322 A1 8/2012 Idsoee
 2012/0226451 A1 9/2012 Bacot et al.
 2012/0226565 A1 9/2012 Drozd
 2012/0226907 A1 9/2012 Hohberger et al.
 2012/0238287 A1 9/2012 Scherzer
 2012/0278188 A1 11/2012 Attar et al.
 2012/0300753 A1 11/2012 Brown et al.
 2012/0310720 A1 12/2012 Balsan et al.
 2013/0019295 A1 1/2013 Park et al.
 2013/0019323 A1 1/2013 Arvidsson et al.
 2013/0044111 A1 2/2013 Vangilder et al.
 2013/0111543 A1 5/2013 Brown et al.
 2013/0135082 A1 5/2013 Xian et al.
 2013/0179201 A1 7/2013 Fuerstenberg et al.
 2013/0219186 A1 8/2013 Giobbi et al.
 2013/0276140 A1 10/2013 Coffing et al.
 2013/0277425 A1 10/2013 Sharma et al.
 2013/0297514 A1 11/2013 Giobbi
 2013/0315210 A1 11/2013 Brown et al.
 2013/0331063 A1 12/2013 Cormier et al.
 2014/0074696 A1 3/2014 Glaser
 2014/0147018 A1 5/2014 Argue et al.
 2014/0266604 A1 9/2014 Masood et al.
 2014/0266713 A1 9/2014 Sehgal et al.
 2014/0337920 A1 11/2014 Giobbi
 2015/0026480 A1 1/2015 Giobbi et al.
 2015/0039451 A1 2/2015 Bonfiglio
 2015/0138330 A1 5/2015 Krishnamoorthi
 2015/0294293 A1 10/2015 Signarsson
 2015/0310385 A1 10/2015 King et al.
 2015/0310440 A1 10/2015 Hynes et al.
 2016/0005020 A1 1/2016 Fernando et al.
 2016/0093081 A1 3/2016 Kim et al.
 2016/0133123 A1 5/2016 Giobbi et al.
 2016/0171200 A1 6/2016 Giobbi
 2016/0203349 A1 7/2016 Giobbi
 2016/0205682 A1 7/2016 Brown et al.
 2016/0210614 A1 7/2016 Hall
 2016/0300236 A1 10/2016 Wiley et al.
 2016/0306956 A1 10/2016 Giobbi
 2017/0041315 A1 2/2017 Giobbi
 2017/0085564 A1 3/2017 Giobbi et al.
 2017/0091548 A1 3/2017 Agrawal et al.
 2017/0270738 A1 9/2017 Giobbi
 2017/0309165 A1 10/2017 Brown et al.
 2017/0353500 A1 12/2017 Jacobsen et al.
 2018/0019998 A1 1/2018 Giobbi
 2018/0129799 A1 5/2018 Giobbi
 2018/0322718 A1 11/2018 Qian et al.
 2018/0357475 A1 12/2018 Honda et al.
 2019/0065721 A1 2/2019 Giobbi
 2019/0172281 A1 6/2019 Einberg et al.
 2019/0260724 A1 8/2019 Hefetz et al.
 2019/0289562 A1 9/2019 Brown
 2020/0351873 A1 11/2020 Brown et al.
 2021/0219869 A1 7/2021 Ryu et al.
 2022/0210643 A1 6/2022 Hynds et al.

FOREIGN PATENT DOCUMENTS

- WO 99/56429 A1 11/1999
 WO 00/62505 A1 10/2000
 WO 01/22724 A1 3/2001
 WO 01/35334 A1 5/2001
 WO 01/75876 A1 10/2001
 WO 01/77790 A1 10/2001
 WO 2004/010774 A1 2/2004
 WO 2004/038563 A2 5/2004
 WO 2005/031663 A2 4/2005
 WO 2005/050450 A1 6/2005
 WO 2005/086802 A2 9/2005
 WO 2007/087558 A2 8/2007

OTHER PUBLICATIONS

- Agourare, K., Mourlin, F., "Authentication and location control via RFID analysis", 2009 IEEE Conference on Emerging Technologies & Factory Automation (pp. 1-8) Publication Date: Sep. 1, 2009 (Year: 2009).*
- IEEE Computer Society, "IEEE Std 802.15.4™—Part 15.4: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (LR-WPANs)," The Institute of Electrical and Electronics Engineers, Inc., New York, NY, Oct. 1, 2003, 679 pgs.
- Micronas, "Micronas and Thomson Multimedia Showcase a New Copy Protection System that Will Drive the Future of Digital Television," Jan. 8, 2002, retrieved from www.micronas.com/press/pressreleases/prnter.php?ID=192 on Mar. 4, 2002, 3 pgs.
- Muller, "Desktop Encyclopedia of the Internet," 1999, Artech House Inc., Norwood, MA, all pages.
- National Criminal Justice Reference Service, "Antenna Types," Dec. 11, 2006, online at <http://ncjrs.gov/pdffiles1/nij/185030b.pdf>, retrieved from http://web.archive.org/web/*/http://www.ncjrs.gov/pdffiles1/nij/185030b.pdf on Jan. 12, 2011, 1 pg.
- Nel et al., "Generation of Keys for use with the Digital Signature Standard (DSS)," Communications and Signal Processing, Proceedings of the 1993 IEEE South African Symposium, Aug. 6, 1993, pp. 6-11.
- Nerd Vitiles, "magicJack: Could It Be the Asterisk Killer?" Aug. 1, 2007, retrieved from <http://nerdvittles.com/index.php?p=187> on or before Oct. 11, 2011, 2 pgs.
- Nilsson et al., "Match-on-Card for Java Cards," Precise Biometrics, white paper, Apr. 2004, retrieved from www.ibia.org/membersadmin/whitepapers/pdf/17/Precise%20Match-on-Card%20for%20Java%20Cards.pdf on Jan. 7, 2007, 5 pgs.

(56)

References Cited

OTHER PUBLICATIONS

- Noore, "Highly Robust Biometric Smart Card Design." IEEE Transactions on Consumer Electronics, vol. 46, No. 4, Nov. 2000, pp. 1059-1063.
- Nordin, "Match-on-Card Technology," Precise Biometrics, white paper, Apr. 2004, retrieved from www.ibia.org/membersadmin/whitepapers/pdf/17/Precise%20Match-on-Card%20technology.pdf on Jan. 7, 2007, 7 pgs.
- Paget, "The Security Behind Secure Extranets," Enterprise Systems Journal, vol. 14, No. 12, Dec. 1999, 4 pgs.
- Pash, "Automate proximity and location-based computer actions," Jun. 5, 2007, retrieved from <http://lifehacker.com/265822/automate-proximity-and-location-based-computer-actions> on or before Oct. 11, 2011, 3 pgs.
- Pope et al., "Oasis Digital Signature Services: Digital Signing without the Headaches," IEEE Internet Computing, vol. 10, Sep./Oct. 2006, pp. 81-84.
- Safink Corporation, "SAFModule™: A Look Into Strong Authentication," white paper, retrieved from www.ibia.org/membersadmin/whitepapers/pdf/6/SAFmod_WP.pdf on Jan. 7, 2007, 8 pgs.
- Sapsford, "E-Business: Sound Waves Could Help Ease Web-Fraud Woes," Wall Street Journal, Aug. 14, 2000, p. B1.
- Singh et al., "A Constraint-Based Biometric Scheme on ATM and Swiping Machine." 2016 International Conference on Computational Techniques in Information and Communication Technologies (ICCTICT), Mar. 11, 2016, pp. 74-79.
- Smart Card Alliance, "Contactless Technology for Secure Physical Access: Technology and Standards Choices," Smart Card Alliance, Oct. 2002, pp. 1-48.
- Smart Card Alliance, "Smart Cards and Biometrics White Paper: Smart Card Alliance," May 2002, retrieved from http://www.securitymanagement.com/library/smartcard_faqtch0802.pdf on Jan. 7, 2007, 7 pgs.
- Smart Card Alliance, "Alliance Activities: Publications: Identity: Identity Management Systems, Smart Cards and Privacy," 1997-2007, retrieved from www.smartcardalliance.org/pages/publications-identity on Jan. 7, 2007, 3 pgs.
- SplashID, "SplashID—Secure Password Manager for PDA's and Smartphones," Mar. 8, 2007, retrieved from <http://www.splashdata.com/splashid/> via <http://www.archive.org/> on or before Oct. 11, 2011, 2 pgs.
- Srivastava, "Is internet security a major issue with respect to the slow acceptance rate of digital signatures," Jan. 2, 2005, Computer Law & Security Report, pp. 392-404.
- Thomson Multimedia, "Thomson multimedia unveils copy protection proposal designed to provide additional layer of digital content security," retrieved from www.thomson-multimedia.com/gb/06/c01/010530.htm on Mar. 4, 2002, May 30, 2001, 2 pgs.
- Unixhelp, "What is a file?" Apr. 30, 1998, retrieved from unixhelp.ed.ac.uk/editors/whatisafile.html accessed Mar. 11, 2010 via http://waybackmachine.org/19980615000000*/http://unixhelp.ed.ac.uk/editors/whatisafile.html on Mar. 11, 2011, 1 pg.
- Vainio, "Bluetooth Security," Helsinki University of Technology, May 25, 2000, 17 pgs.
- Van Winkle, "Bluetooth: The King of Connectivity," Laptop Buyer's Guide and Handbook, Jan. 2000, pp. 148-153.
- Wade, "Using Fingerprints to Make Payments at POS Slowly Gaining Popularity," Credit Union Journal, International Biometric Group, Apr. 21, 2003, retrieved from http://www.biometricgroup.com/in_the_news/04.21.03.html on Jan. 7, 2007, 3 pgs.
- Wallace, "The Internet Unplugged," InformationWeek, vol. 765, No. 22, Dec. 13, 1999, pp. 22-24.
- Weber, "In the Age of Napster, Protecting Copyright is a Digital Arms Race," Wall Street Journal, Jul. 24, 2000, B1, 2 pgs.
- White, "How Computers Work," Millennium Edition, 1999, Que Corporation, Indianapolis, IN, all pages.
- Yoshida, "Content Protection Plan Targets Wireless Home Networks," EE Times, Jan. 11, 2002, retrieved from www.eetimes.com/story/OEG20020111S0060 on Mar. 4, 2002, 2 pgs.
- Anonymous, "Applying Biometrics to Door Access," Security Magazine, Sep. 26, 2002, retrieved from http://www.securitymagazine.com/CDA/Articles/Technologies/3ae610eaa34d8010VgnVCM100000f932a8c0__on Jan. 7, 2007, 5 pgs.
- Anonymous, "Firecrest Shows How Truly Commercially-Minded Companies Will Exploit the Internet," Computergram International, Jan. 18, 1996, 2 pgs.
- Anonymous, "IEEE 802.15.Apr. 2006—Wikipedia, the free encyclopedia," Wikipedia, last modified Mar. 21, 2009, retrieved from http://en.wikipedia.org/wiki/IEEE_802.15.4-2006 on Apr. 30, 2009, 5 pgs.
- Antonoff, "Visiting Video Valley," Sound & Vision, Nov. 2001, pp. 116, 118-119.
- Apple et al., "Smart Card Setup Guide," 2006, downloaded from http://manuals.info.apple.com/en_US/Smart_Card_Setup_Guide.pdf on or before May 3, 2012, 16 pgs.
- Balanis, "Antenna Theory: A Review," Jan. 1992, Proceedings of the IEEE, vol. 80, No. 1, p. 13.
- Beaufour, "Personal Servers as Digital Keys," Proceedings of the Second IEEE Annual Conference on Pervasive Computing and Communications (PERCOM'04), Mar. 14-17, 2004, pp. 319-328.
- Biopay, LLC, "Frequently Asked Questions (FAQs) About BioPay," retrieved from <http://www.biopay.com/faqs-lowes.asp> on Jan. 7, 2007, 5 pgs.
- Blueproximity, "BlueProximity—Leave it—it's locked, come back, it's back too . . ." Aug. 26, 2007, retrieved from <http://blueproximity.sourceforge.net/viahttp://www.archive.org/on> or before Oct. 11, 2011, 1 pg.
- Bluetooth Sig, Inc., "Bluetooth," www.bluetooth.com, Jun. 1, 2000, 8 pgs.
- Bluetooth Sig, Inc., "Say Hello to Bluetooth," www.bluetooth.com, Jan. 14, 2005, 5 pgs.
- Blum, "Digital Rights Management May Solve the Napster 'Problem,'" Technology Investor, Oct. 2000, pp. 24-27.
- Bohrsatom et al., "Automatically unlock PC when entering proximity," Dec. 7, 2005, retrieved from <http://salling.com/forums/viewtopic.php?t=3190> on or before Oct. 11, 2011, 3 pgs.
- Brown, "Techniques for Privacy and Authentication in Personal Communication Systems," Personal Communications, IEEE, Aug. 1995, vol. 2, No. 4, pp. 6-10.
- Chen et al., "On Enhancing Biometric Authentication with Data Protection." KES2000. Fourth International Conference on Knowledge-Based Intelligent Engineering Systems and Allied Technologies. Proceedings (Cat. No.00TH8516), vol. 1, Aug. 1, 2000, pp. 249-252.
- Cisco Systems, Inc., "Antenna Patterns and Their Meaning," 1992-2007, p. 10.
- Costa, "Imation USB 2.0 Micro Hard Drive," Nov. 22, 2005, retrieved from <http://www.pcmag.com/article2/0,2817,1892209,00.asp> on or before Oct. 11, 2011, 2 pgs.
- Dagan, "Power over Ethernet (PoE) Midspan—The Smart Path to Providign Power for IP Telephony," Product Manager, Systems, Aug. 2005, Power Dsine Inc., 28 pgs.
- Dai et al., "Toward Blockchain-Based Accounting and Assurance," Journal of Information Systems, vol. 31, No. 3, Fall 2017, pp. 5-21.
- Debow, "Credit/Debit Debuts in Midwest Smart Card Test," Computers in Banking, vol. 6, No. 11, Nov. 1989, pp. 10-13.
- Dennis, "Digital Passports Need Not Infringe Civil Liberties," Newsbytes, NA, Dec. 2, 1999, 2 pgs.
- Derfler, "How Networks Work," Bestseller Edition, 1996, Ziff-Davis Press, Emeryville, CA, all pages.
- Farouk et al., "Authentication Mechanisms in Grid Computing Environment: Comparative Study," IEEE, Oct. 2012, pp. 1-6.
- Fasca, "S3, Via Formalize Agreement," Electronic News, The Circuit, 45(45, Nov. 8, 1999), p. 20.
- Giobbi, Specification of U.S. Appl. No. 60/824,758, filed Sep. 6, 2006, all pages.
- Govindan et al., "Real Time Security Management Using RFID, Biometric and Smart Messages." 2009 3rd International Conference on Anti-Counterfeiting, Security, and Identification in Communication, Aug. 20, 2009, pp. 282-285.

(56)

References Cited

OTHER PUBLICATIONS

Gralla, "How the Internet works," Millennium Edition, 1999, Que Corporation, Indianapolis, IN, all pages.

Hendron, "File Security, Keychains, Encryption, and More with Mac OS X (10.3+)" Apr. 4, 2005, downloaded from http://www.johnhendron.net/documents/OSX_Security.pdf on or before May 3, 2012, 30 pgs.

International Search Report and Written Opinion for International Application No. PCT/US04/38124, dated Apr. 7, 2005, 10 pgs.

International Search Report and Written Opinion for International Application No. PCT/US05/00349, dated Mar. 19, 2008, 10 pgs.

International Search Report and Written Opinion for International Application No. PCT/US05/07535, dated Dec. 6, 2005, 6 pgs.

International Search Report and Written Opinion for International Application No. PCT/US05/43447, dated Feb. 22, 2007, 7 pgs.

International Search Report and Written Opinion for International Application No. PCT/US05/46843, dated Mar. 1, 2007, 10 pgs.

International Search Report and Written Opinion for International Application No. PCT/US07/11102, dated Oct. 3, 2008, 11 pgs.

International Search Report and Written Opinion for International Application No. PCT/US07/11103, dated Apr. 23, 2008, 9 pgs.

International Search Report and Written Opinion for International Application No. PCT/US07/11104, dated Jun. 26, 2008, 9 pgs.

International Search Report and Written Opinion for International Application No. PCT/US07/11105, dated Oct. 20, 2008, 10 pgs.

International Search Report and Written Opinion for International Application No. PCT/US08/83060, dated Dec. 29, 2008, 9 pgs.

International Search Report and Written Opinion for International Application No. PCT/US08/87835, dated Feb. 11, 2009, 8 pgs.

International Search Report and Written Opinion for International Application No. PCT/US09/34095, dated Mar. 25, 2009, 11 pgs.

International Search Report and Written Opinion for International Application No. PCT/US2009/039943, dated Jun. 1, 2009, 9 pgs.

International Search Report and Written Opinion for International Application No. PCT/US2014/037609, dated Dec. 9, 2014, 13 pgs.

Jeyaprakash et al., "Secured Smart Card Using Palm Vein Biometric On-Card-Process," 2008 International Conference on Convergence and Hybrid Information Technology, 2008, pp. 548-551.

Katz et al., "Smart Cards and Biometrics in Privacy-Sensitive Secure Personal Identification System," May 2002, Smart Card Alliance, 22 pgs.

Kontzer, "Thomson Bets on Smart Cards for Video Encryption," www.informationweek.com, Jun. 7, 2001, 1 pg.

Lake, "Downloading for Dollars: Who said buying music off the Net would be easy?" *Sound & Vision*, Nov. 2000, pp. 137-138.

Lee et al., "Effects of dielectric superstrates on a two-layer electromagnetically coupled patch antenna," *Antennas and Propagation Society International Symposium*, Jun. 1989, AP-S. Digest, vol. 2, pp. 26-30, found at <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1347>.

Lewis, "Sony and Visa in On-Line Entertainment Venture," *New York Times*, vol. 145, Thurs. Ed., Nov. 16, 1995, 1 pg.

Liu et al., "A Practical Guide to Biometric Security Technology," *IT Pro*, vol. 3, No. 1, Jan./Feb. 2001, pp. 27-32.

McIver et al., "Identification and Verification Working Together," *Bioscrypt*, White Paper: Identification and Verification Working Together, Aug. 27, 2004, retrieved from www.ibia.org/membersadmin/whitepapers/pdf/15/Idenification%20and%20Verification%20Working%20Together.pdf on Jan. 7, 2007, 5 pgs.

University of Birmingham, "PRISM: Probabilistic Symbolic Model Checker," at least as early as Aug. 3, 2004, 3 pgs., archived at <https://web.archive.org/web/20040803193058/http://www.cs.bham.ac.uk/~dpx/prism/casestudies/index.html>.

Weissman, "Indoor Location," Tadlys Ltd. white paper, at least as early as Oct. 31, 2004, 15 pgs., archived at https://web.archive.org/web/20041031125859/http://www.tadlys.com/media/downloads/Indoors_Location_Systems.pdf.

Zigbee Alliance, "Welcome to the ZigBee™ Alliance," exemplary web page, at least as early as Sep. 24, 2004, 2 pgs., archived at <https://web.archive.org/web/20040924045517/http://zigbee.org/>.

Zigbee Alliance, "ZigBee Specification," ZigBee Document 053474r06, Version 1.0, Dec. 14, 2004, 378 pgs.

Zigbee Alliance, "The ZigBee™ Buzz Is Growing: New Low-Power Wireless Standard Opens Powerful Possibilities," *Electronic Design*, Jan. 12, 2004, 12 pgs., archived at https://web.archive.org/web/20040411172015/http://www.elecdesign.com/Files/29/7186/7186_01.pdf.

Zigbee Alliance, "ZigBee™ Positioned to Drive Wireless Networking in Building Automation, Industrial and Residential Control and Sensors Markets in 2004," press release, Feb. 17, 2004, 3 pgs., archived at https://web.archive.org/web/20040423220244/http://www.zigbee.org/documents/04036r5ZB_MWG-Momentum-Release_FINAL.pdf.

Adams, "Designing with 802.15.4 and Zigbee," presented at Industrial Wireless Applications Summit, San Diego, California, Mar. 9, 2004, 22 pgs.

Adams, "Meet the ZigBee Standard," *Sensors Online*, Jun. 2003, 7 pgs., archived at https://web.archive.org/web/20031008191032/http://sensorsmag.com/articles/0603/14/pf_main.shtml.

Adams, "Zigbee vital in industrial applications," *EE Times*, Jul. 29, 2003, 3 pgs., archived at <https://web.archive.org/web/20031013062940/http://www.eetimes.com/story/OEG20030727S0002>.

Blip Systems, "Mar. 8, 2004—Bluetooth at the office?" at least as early as Oct. 11, 2004, archived at <https://web.archive.org/web/20041011094320/http://www.blipsystems.com/Default.asp?ID=16&M=News&PID=25&NewsID=9>.

Blip Systems, "BlipManager," at least as early as May 17, 2004, 1 pg., archived at <https://web.archive.org/web/20040517050728/http://www.blipsystems.com/Default.asp?ID=11>.

Blip Systems, "BlipMobility," at least as early as Apr. 7, 2004, archived at <https://web.archive.org/web/20040407212934/http://www.blipsystems.com/Default.asp?ID=118>.

Blip Systems, "BlipNet API," at least as early as May 18, 2004, 1 pg., archived at <https://web.archive.org/web/20040518060132/http://www.blipsystems.com/Default.asp?ID=92>.

Blip Systems, "BlipNet Explore a wireless world . . . of great opportunities," brochure available Sep. 2002, 6 pgs., available online at https://web.archive.org/web/20031012184406/http://www.blipsystems.com/products_blipnet.shtml.

Blip Systems, "BlipNet Technical Overview," Mar. 2003, 30 pgs., archived at https://web.archive.org/web/20031012184406/http://www.blipsystems.com/products_blipnet.shtml.

Blip Systems, "BlipNode," at least as early as May 16, 2004, 1 pg., archived at <https://web.archive.org/web/20040516001554/http://www.blipsystems.com/Default.asp?ID=10>.

Blip Systems, "BlipServer," at least as early as May 17, 2004, 1 pg., archived at <https://web.archive.org/web/20040517044955/http://www.blipsystems.com/Default.asp?ID=9>.

Blip Systems, "Bluetooth Networks: Products: Bluetooth infrastructure," product description, at least as early as Oct. 2003, archived at https://web.archive.org/web/20031012184406/http://www.blipsystems.com/products_blipnet.shtml.

Blip Systems, "Product Information—BlipNet—Presentation of BlipNet 1.0—A Bluetooth Access System," Aug. 2002, 2 pgs., archived at https://web.archive.org/web/20031012184406/http://www.blipsystems.com/products_blipnet.shtml.

Bluetooth Sig, Inc. "Specification of the Bluetooth System," Version 1.2, Nov. 5, 2003, 82 pgs., archived at <https://web.archive.org/web/20031119092849/http://www.bluetooth.com/dev/spec.v12.asp>.

Callaway, "Wireless Sensor Networks: Architectures and Protocols," book description, Motorola Labs, Auerbach Publications, Aug. 26, 2003, 3 pgs., archived at https://web.archive.org/web/20031023101953/http://www.crcpress.com/shopping_cart/products/product_detail.asp?sku=AU1823.

Chi et al., "Industrial Wireless Sensor Networking: A Market Dynamics Study," *On World*, Jun. 28, 2004, 5 pgs., archived at <https://web.archive.org/web/20040710182216/http://onworld.com:80/html/industrialwirelessensor.htm>.

Duflot et al., "A Formal Analysis of Bluetooth Device Discovery," presented at the 1st International Symposium on Leveraging Applications of Formal Methods (ISOLA'04), Oct. 30-Nov. 2, 2004, Paphos, Cyprus, and published in the *International Journal on*

(56)

References Cited

OTHER PUBLICATIONS

Software Tools for Technology Transfer 8, pp. 621-632, 16 pgs., <https://doi.org/10.1007/s10009-006-0014-x>.

Eshed, "Bluetooth Wireless Technology Application for the Retail Market," published at www.tadlys.com on May 2001, 8 pgs.

Freescale Semiconductor, Inc., "Freescale Events," see ZigBee Open House Event, Aug. 18, 2004, 6 pgs., archived at https://web.archive.org/web/20040909082726/https://www.freescale.com/webapp/sps/site/overview.jsp?nodeId=02XPgQ7JgbBqJQ#zigbee_openhouse_04.

Freescale Semiconductor, Inc., "Overview," ZigBee General Information, at least as early as Aug. 17, 2004, 1 pg., archived at <https://web.archive.org/web/20040817210006/http://www.freescale.com/webapp/sps/site/overview.jsp?nodeId=02XPgQhHPRjdyB37087725>.

Freescale Semiconductor, Inc., "ZigBeeTM," Freescale Semiconductor Wireless Standards, at least as early as Aug. 18, 2004, 2 pgs., archived at <https://web.archive.org/web/20040818075046/http://www.freescale.com/webapp/sps/site/overview.jsp?nodeId=02XPgQhHPRjdyB>.

Freescale Semiconductor, Inc., "ZigBeeTM," Freescale Semiconductor Wireless Standards, at least as early as Jun. 11, 2004, 2 pgs., archived at <https://web.archive.org/web/20040611051834/http://www.motorola.com/webapp/sps/site/overview.jsp?nodeId=02XPgQhHPRjdyB>.

Freescale Semiconductor, Inc., "Freescale's ZigBeeTM-ready Platform Wins Sensors Magazine Best of Sensors Expo Award," Freescale Semiconductor Wireless, at least as early as Aug. 17, 2004, 1 pg., archived at https://web.archive.org/web/20040817203409mp_/http://www.freescale.com/webapp/sps/site/overview.jsp?nodeId=02XPgQ6988.

Freescale Semiconductor, Inc., "ZigBee Alliance Successfully Concludes First Multi-node Network Test," press release, Jul. 6, 2004, 2 pgs., archived at https://web.archive.org/web/20040717113733/http://www.zigbee.org/documents/First-Multi-Node_Testing_FINAL_000.pdf.

Freescale Semiconductor, Inc., "ZigBeeTM Technology from Freescale," Freescale Semiconductor, Inc. white paper, 2004, 4 pgs., archived at https://web.archive.org/web/20050513024652/http://www.freescale.com/files/wireless_comm/doc/brochure/BRZIGBEETECH.pdf.

Freescale Semiconductor, Inc., "ZRP-1 : ZigBee-ready Platform," at least as early as Oct. 19, 2005, 6 pgs., archived at https://web.archive.org/web/20051019122919/http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=ZRP-1&nodeId=02XPgQhCQ6m6cy7103.

Freescale Semiconductor, Inc., M68HC08 microcontroller ordering web page, at least as early as Aug. 17, 2004, 5 pgs., archived at <https://web.archive.org/web/20040817014804/http://www.freescale.com/webapp/sps/site/taxonomy.jsp?nodeId=01624684498634>.

IBM Corporation, "Tadlys' Bluetooth Wireless Local Network for Corporate," Wireless e-business, at least as early as May 6, 2004, 2 pgs., archived at <https://web.archive.org/web/20040621130525/http://www.tadlys.com/media/downloads/Corporate%20PVDEE01005-3.pdf>.

IBM Corporation, "Tadlys' Bluetooth Wireless Local Network for Hotspots," Wireless e-business, at least as early as May 6, 2004, 2 pgs., archived at <https://web.archive.org/web/20040508123915/http://www.tadlys.com/media/downloads/Hotspots%20PVDEE01006-3.pdf>.

IEEE, "IEEE 802.15 WPANTM Task Group 4 (TG4)" exemplary web page, Aug. 24, 2004, 2 pgs., archived at <https://web.archive.org/web/20040824085452/http://www.ieee802.org/15/pub/TG4.html>.

Korzeniowski, "First Intelligent, Wireless Consumer Devices About to Hit Market," TechNewsWorld, Jul. 28, 2004, 3 pgs., archived at <https://web.archive.org/web/20040821061130/http://www.technewsworld.com/story/35376.html%20com/>.

Malan, "Here come Wireless Sensors," Machine Design, Jun. 10, 2004, 3 pgs., archived at <https://web.archive.org/web/20040610131354/>

<http://www.machinedesign.com/ASP/viewSelectedArticle.asp?strArticleId=56796&strSite=MDSite&Screen=CURRENTISSUE>.

MIT Computer Science and Artificial Intelligence Laboratory, "Cricket v2 User Manual," Cricket Project, MIT Computer Science and Artificial Intelligence Lab, Cambridge, MA, Jan. 2005, 57 pgs., available online at <https://web.archive.org/web/20041206144922/http://cricket.csail.mit.edu/v2man.html>.

MIT Computer Science and Artificial Intelligence Laboratory, "The Cricket Indoor Location System," at least as early as Nov. 19, 2004, 6 pgs., archived at <https://web.archive.org/web/20041119183049/http://cricket.csail.mit.edu/>.

Motorola, Inc., "Motorola First to Demonstrate ZigBee 2.4 GHz Wireless Networking Technology," press release, Mar. 27, 2003, 2 pgs., archived at https://web.archive.org/web/20050205053308/http://www.motorola.com/mediacenter/news/detail/0,1958,2743_2228_23,00.html.

Priyantha, "The Cricket Indoor Location System," PhD. thesis submitted to Department of Electrical Engineering and Computer Science, Massachusetts Institute of Technology, Jun. 2005, 199 pgs. Rodriguez et al., "In-building location using Bluetooth," Proceedings of the International Workshop on Wireless Ad-Hoc Networks (IWWAN 2005), May 23-26, 2005, London, England, 7 pgs.

Tadlys Ltd., "'Hotspot' Gaming Arcade," at least as early as Dec. 9, 2004, 2 pgs., archived at https://web.archive.org/web/20041209234518/http://www.tadlys.com/media/downloads/Tadlys_gaming_arcade.pdf.

Tadlys Ltd., "About Tadlys," at least as early as Apr. 5, 2001, 1 pg., archived at <https://web.archive.org/web/20010405044249/http://www.tadlys.com/about.html>.

Tadlys Ltd., "An Advertisers' Dream—From direct marketing to sales," Nov. 2004, 2 pgs., archived at https://web.archive.org/web/20041101092944/http://www.tadlys.com/media/downloads/m-commerce_app.pdf.

Tadlys Ltd., "Bluetooth Glossary," at least as early as Jun. 2004, 12 pgs., archived at https://web.archive.org/web/20040531082349/http://www.tadlys.com/pages/Downloads_content.asp?intGlobalId=1.

Tadlys Ltd., "First Demo of Distribution and Redemption of e-Coupons over Bluetooth," Tadlys Company News and Events, Jun. 5, 2001, 1 pg., archived at https://web.archive.org/web/20040601051516/http://tadlys.com/Pages/news_content.asp?iGlobalID=17.

Tadlys Ltd., "Indoor Location Networks," at least as early as Apr. 3, 2004, 1 pg., archived at https://web.archive.org/web/20040403200221/http://www.tadlys.com/Pages/Product_content.asp?iGlobalId=2.

Tadlys Ltd., "Operator Systems," at least as early as Nov. 1, 2004, 2 pgs., archived at https://web.archive.org/web/20041101101402/http://www.tadlys.com/media/downloads/operator_network.pdf.

Tadlys Ltd., "Tadlys Announces Range of Bluetooth Access Network Solutions," Tadlys Company News and Events, Jan. 22, 2001, 1 pg., archived at https://web.archive.org/web/20040624122319/http://www.tadlys.com/Pages/news_content.asp?iGlobalID=16.

Tadlys Ltd., "Tadlys' Wire free networking solutions," Feb. 2001, 2 pgs., archived at <https://web.archive.org/web/20010204012700/http://www.tadlys.com/solutions.html>.

Tadlys Ltd., "Wireless hospital network," at least as early as Jul. 1, 2004, 2 pgs., archived at https://web.archive.org/web/20040701105046/http://www.tadlys.com/media/downloads/tadlys_hospital_wireless_network.pdf.

Tadlys Ltd., "Wireless Museum Information," at least as early as Dec. 12, 2005, 2 pgs., archived at https://web.archive.org/web/20051212162456/http://www.tadlys.com/media/downloads/Tadlys_wireless_museum_network.pdf.

Tadlys Ltd., "Corporate Systems," at least as early as Nov. 1, 2004, 2 pgs., archived at https://web.archive.org/web/20041101095441/http://www.tadlys.com/media/downloads/Corporate_network.pdf.

Thongthammachart et al., "Bluetooth Enables In-door Mobile Location Services," Proceedings of the 57th IEEE Semiannual Vehicular Technology Conference, Apr. 22-25, 2003, 5 pgs.

Schneier, Applied Cryptography, Second Edition: Protocols, Algorithms, and Source Code in C, Jan. 1, 1996, John Wiley & Sons, Inc., 1027 pgs.

(56)

References Cited

OTHER PUBLICATIONS

Beaufour et al., "Personal servers as digital keys," Proceedings of the Second IEEE Annual Conference on Pervasive Computing and Communications, 2004, pp. 319-328, doi: 10.1109/PERCOM.2004.1276869.

Callaway, *Wireless Sensor Networks: Architectures and Protocols*, Jan. 1, 2004, Auerbach Publications, 366 pgs.

Dvorak, *IEEE 802.15.4 and Zigbee Overview*, Sep. 27, 2005, Motorola, 26 pgs.

Hester et al., "neurFon(TM) Netform: A Self-Organizing Wireless Sensor Network", Oct. 14, 2002, Proceedings of the Eleventh International Conference on Computer Communications and Networks, pp. 364-369.

Honkanen et al., "Low End Extension for Bluetooth", Sep. 19, 2004, Proceedings of the 2004 IEEE Radio and Wireless Conference, Atlanta, GA, pp. 199-202.

Jonker et al., "Digital rights management in consumer electronics products," *IEEE Signal Processing Magazine*, vol. 21, No. 2, pp. 82-91, Mar. 2004, doi: 10.1109/MSP.2004.1276116.

Zhang et al., "A User-Centric M-Payment Solution," The ISG-Smart Card Centre and the Information Security Group, Royal Holloway, University of London, Egham, Surrey, TW20 0EX, UK, 2005, 8 pgs.

David et al., *Security Issues for Contactless Smart Cards*, Sep. 1, 1997, conference paper, available online at <https://link.springer.com/chapter/10.1007/BFb0054029>, 6 pgs.

Kuhn et al., *Introduction to Public Key Technology and the Federal PKI Infrastructure*, Feb. 26, 2001, National Institute of Standards and Technology, 54 pgs.

Petition for Inter Partes Review of U.S. Pat. No. 9,049,188, Aug. 26, 2021, 800 pgs.

Petition for Inter Partes Review of U.S. Pat. No. 9,235,700, Aug. 26, 2021, 466 pgs.

Request for Ex Parte Reexamination of U.S. Pat. No. 10,698,989, Jun. 8, 2022, 1505 pgs.

Request for Ex Parte Reexamination of U.S. Pat. No. 8,352,730, Jun. 8, 2022, 1401 pgs.

Request for Ex Parte Reexamination of U.S. Pat. No. 9,298,905, Jun. 8, 2022, 1123 pgs.

Smart Card Alliance, *Contactless Payment and the Retail Point of Sale: Applications, Technologies and Transaction Models*, Mar. 1, 2003, a Smart Card Alliance Report, 50 pgs.

Smart Card Alliance, *Smart Card Alliance—The Alliance*, Jan. 22, 2001, <http://www.smartcardalliance.org>, 1 pg.

Petition for Inter Partes Review of U.S. Pat. No. 10,698,989, Aug. 26, 2021, 3356 pgs.

Petition for Inter Partes Review of U.S. Pat. No. 8,352,730, Aug. 26, 2021, 2450 pgs.

Petition for Inter Partes Review of U.S. Pat. No. 9,298,905, Aug. 26, 2021, 1941 pgs.

Labrou et al., "Wireless Wallet," Proceedings of the First Annual International Conference on Mobile and Ubiquitous Systems: Networking and Services (MobiQuitos '04), IEEE, Aug. 22-26, 2004, 10 pgs.

* cited by examiner

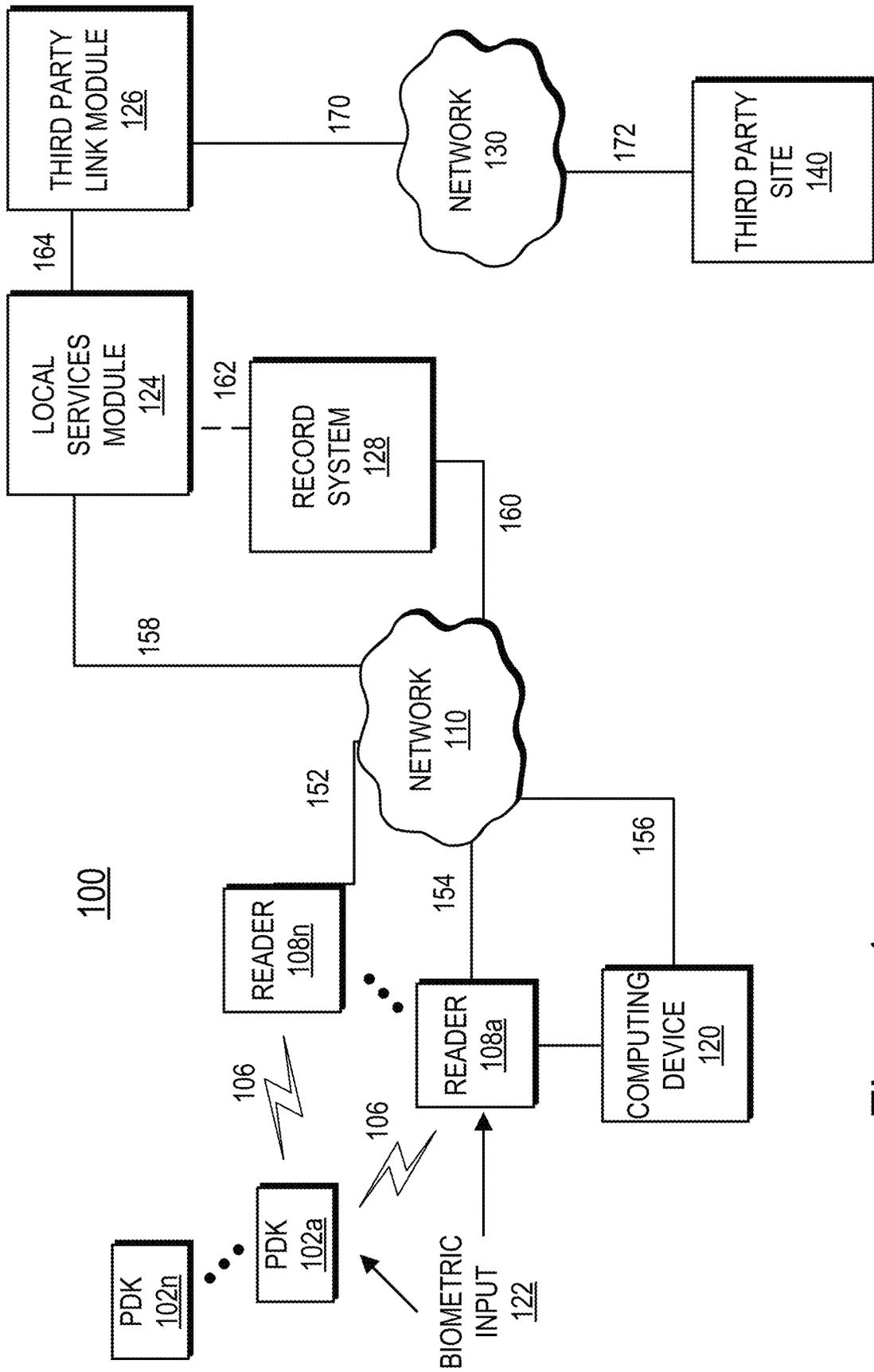


Figure 1

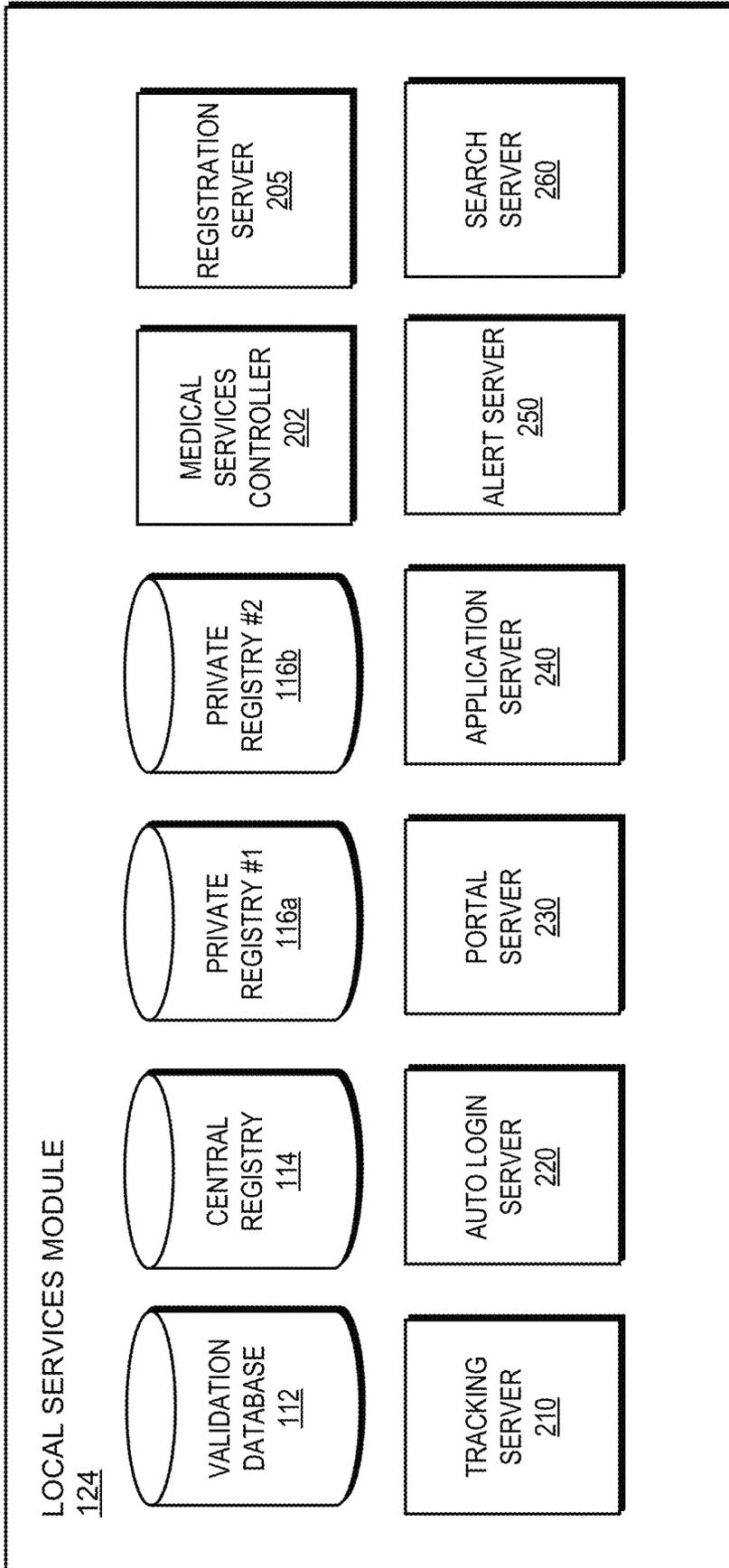


Figure 2

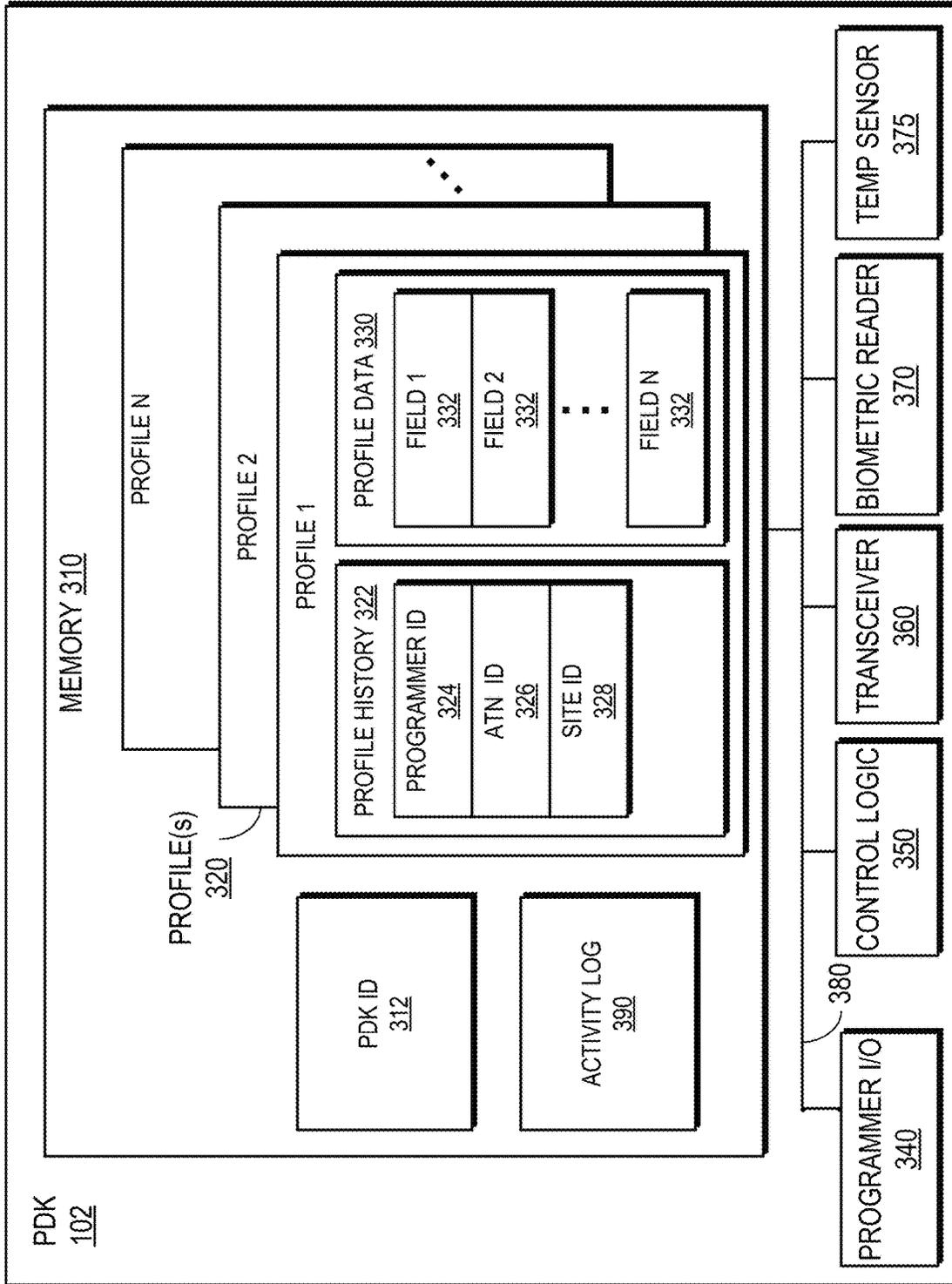


Figure 3

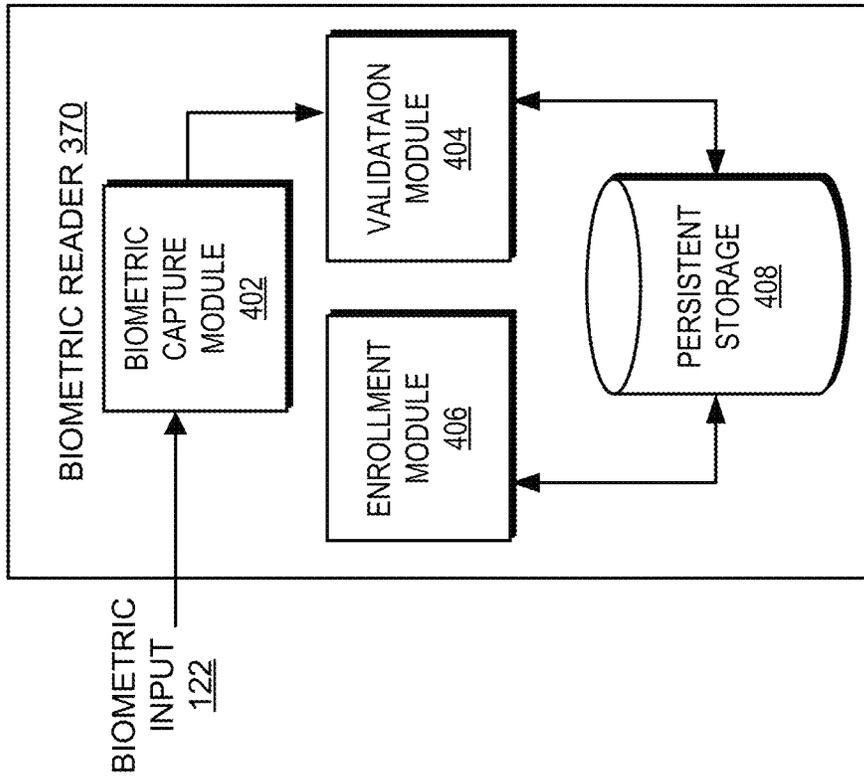


Figure 4

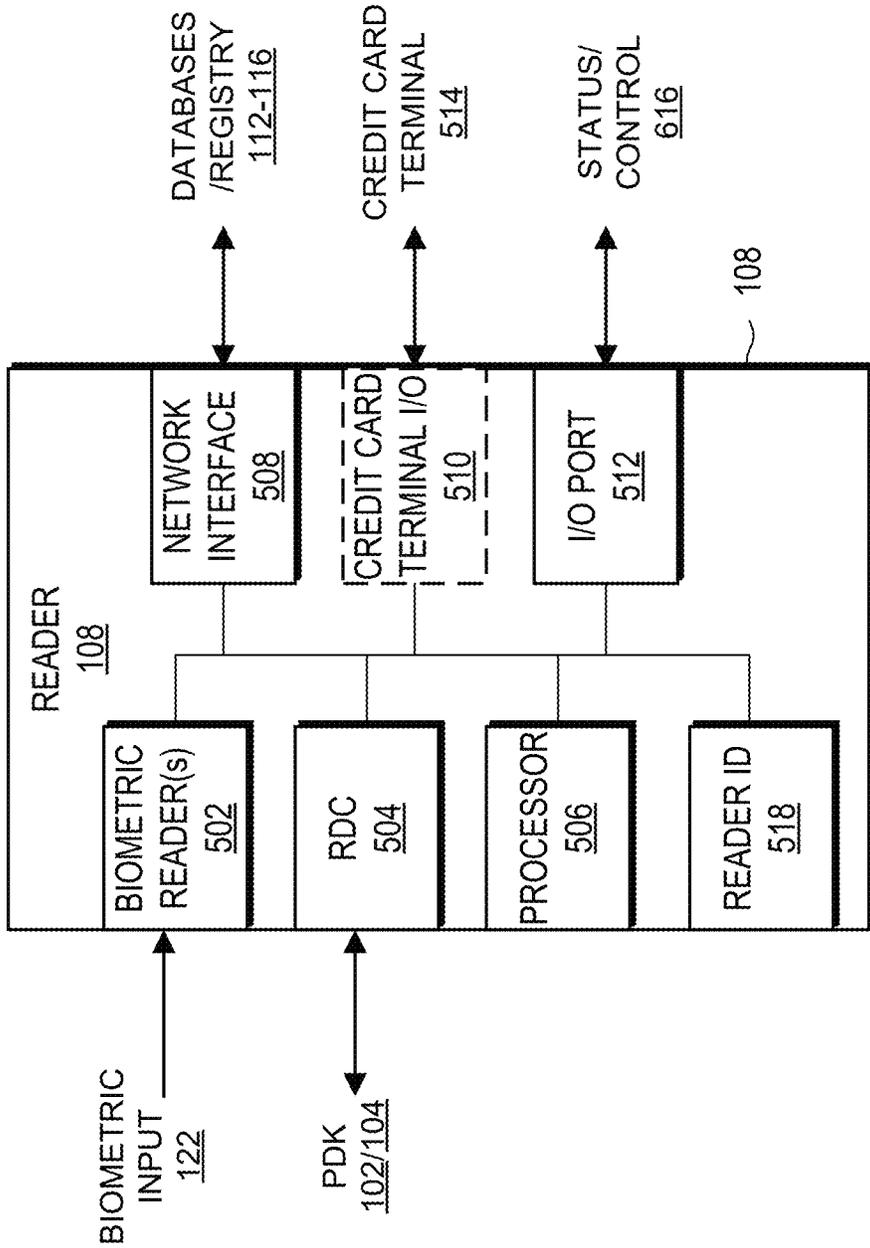


Figure 5

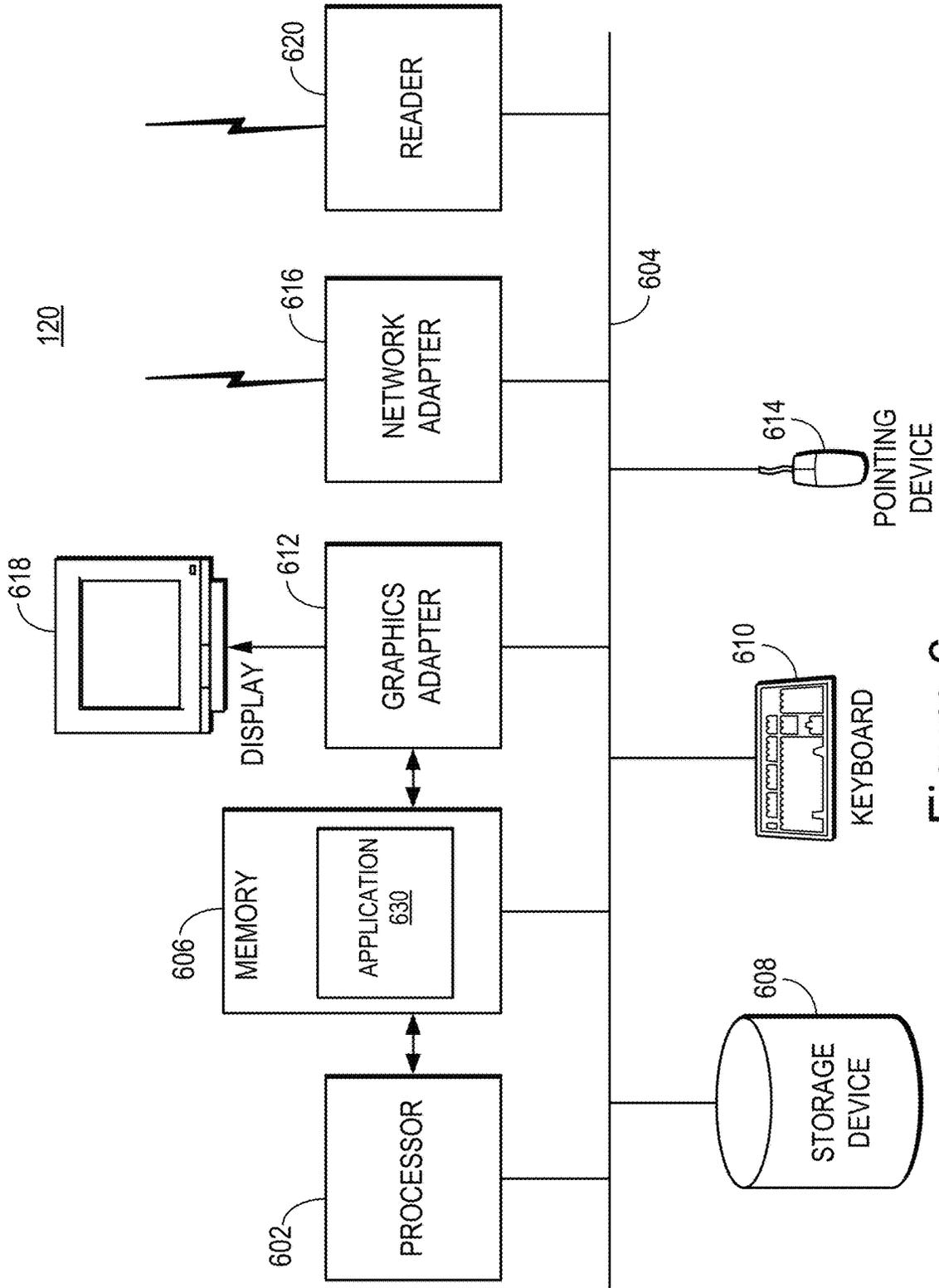


Figure 6

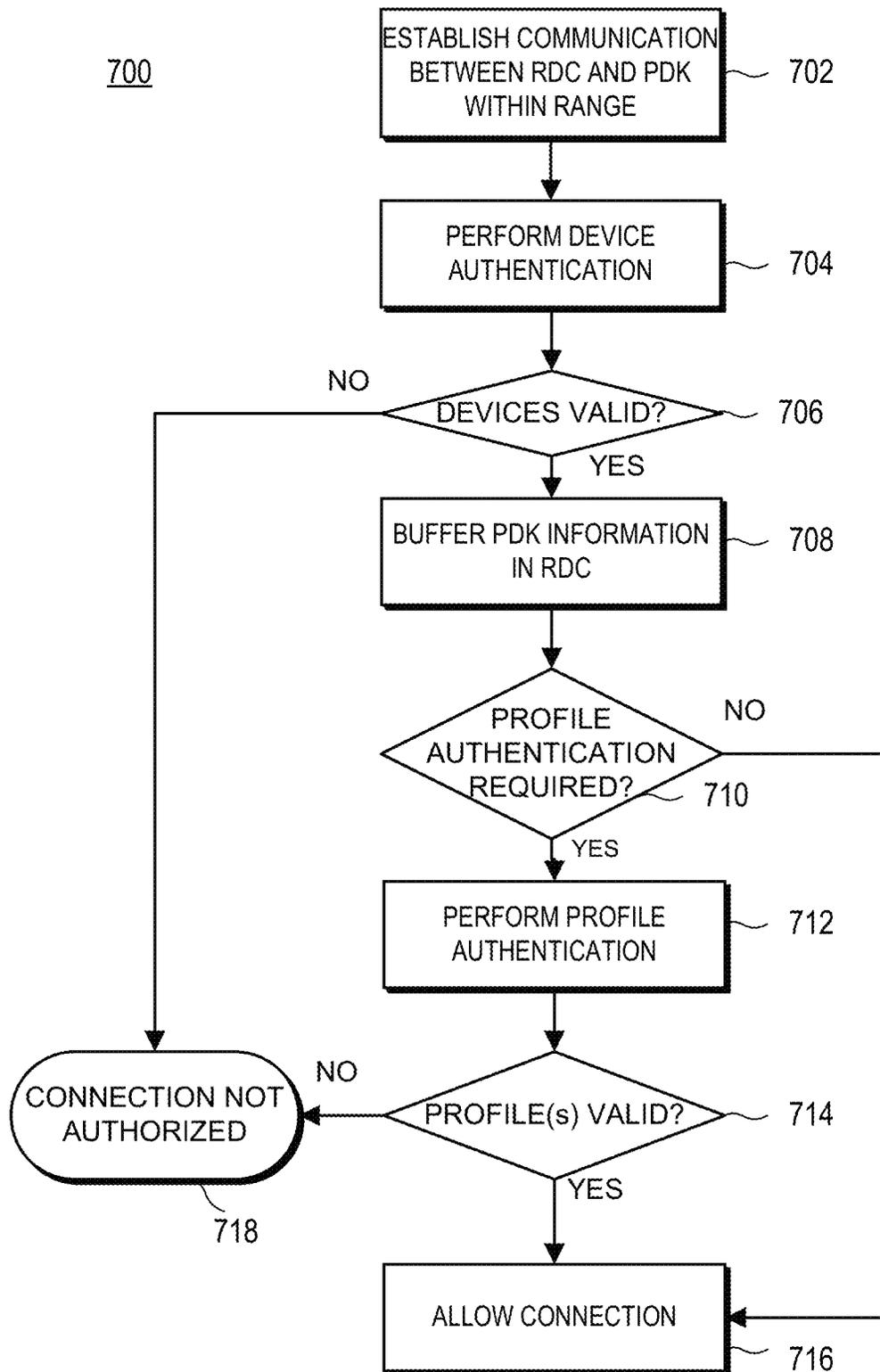


Figure 7

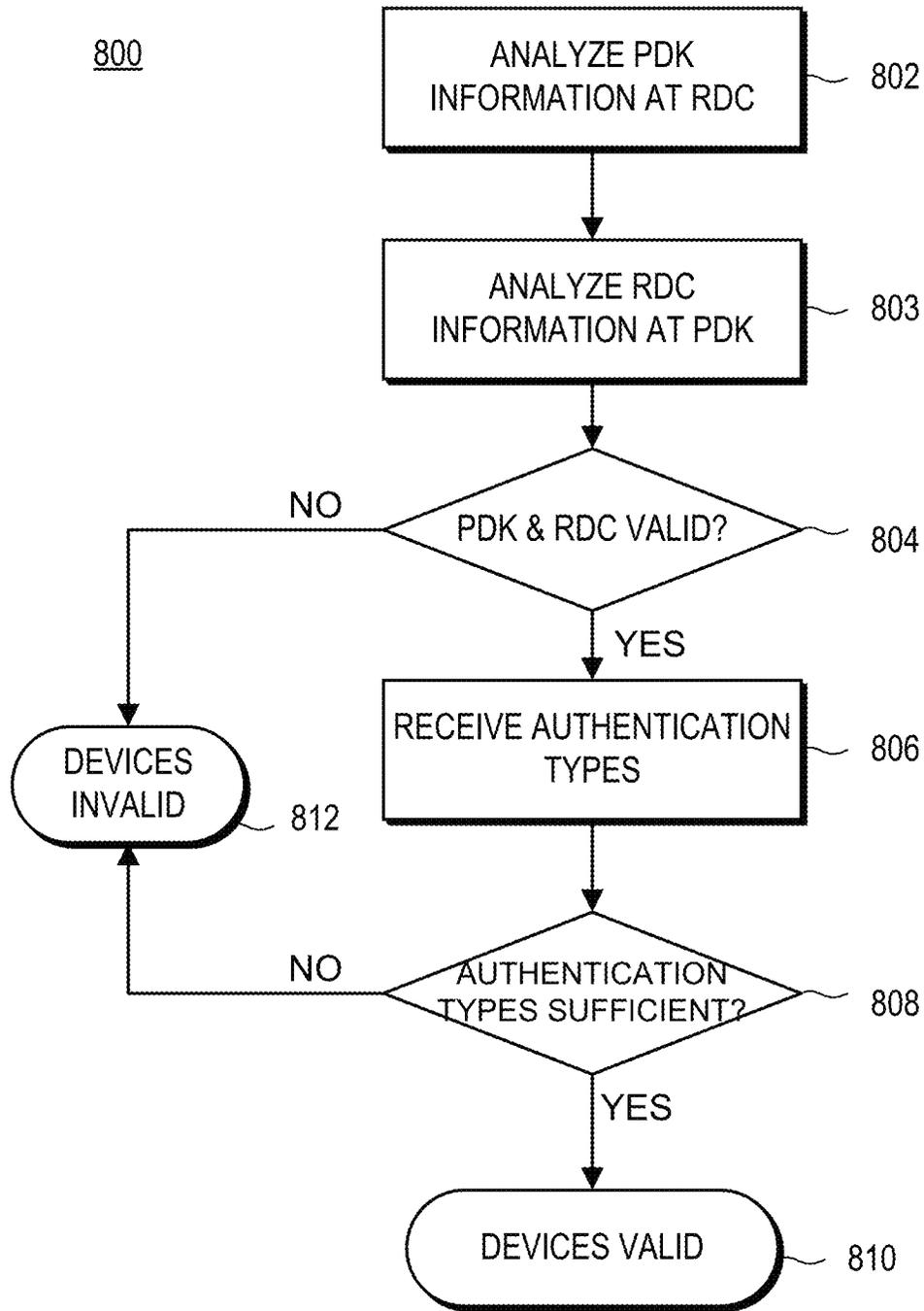


Figure 8

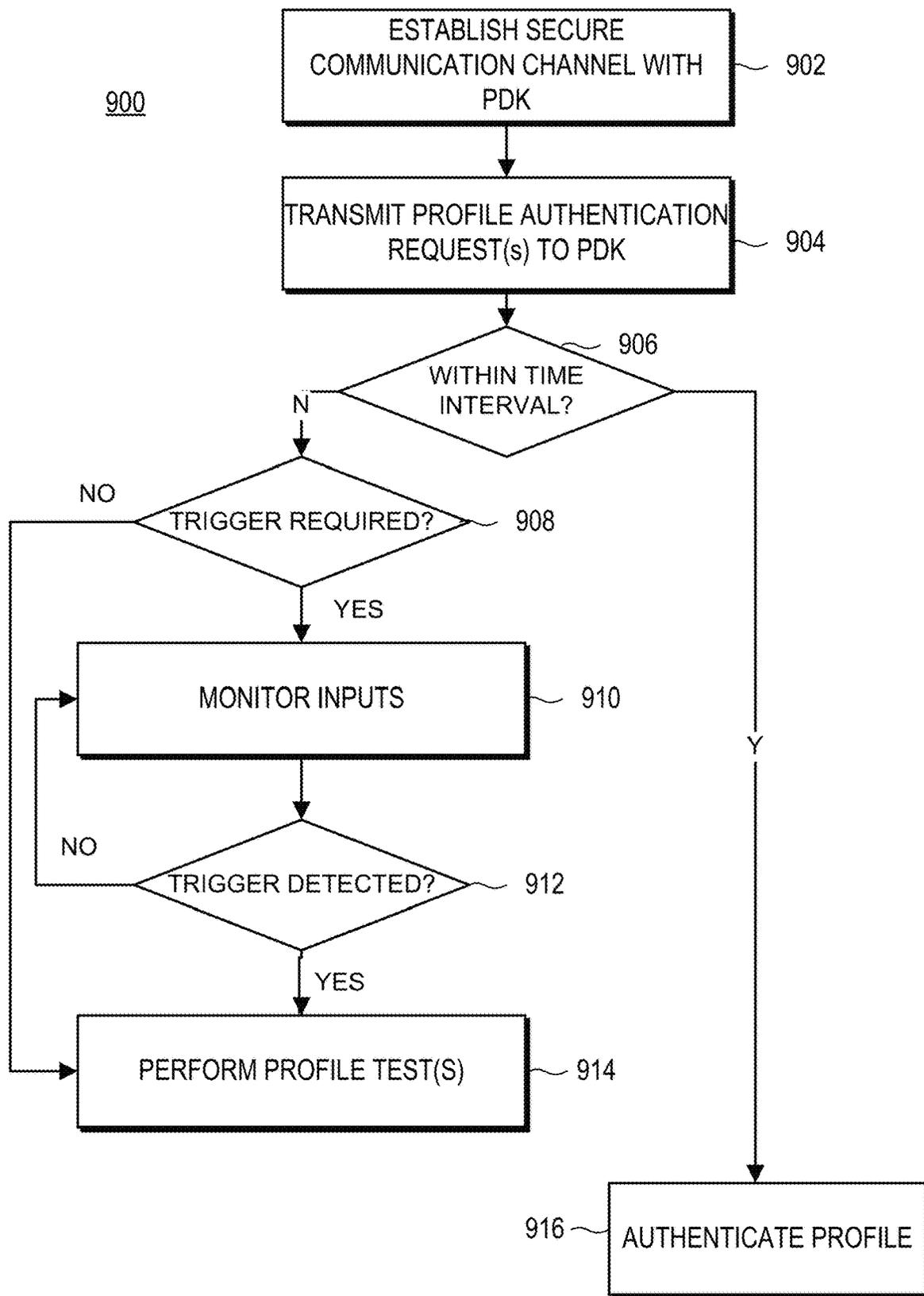


Figure 9

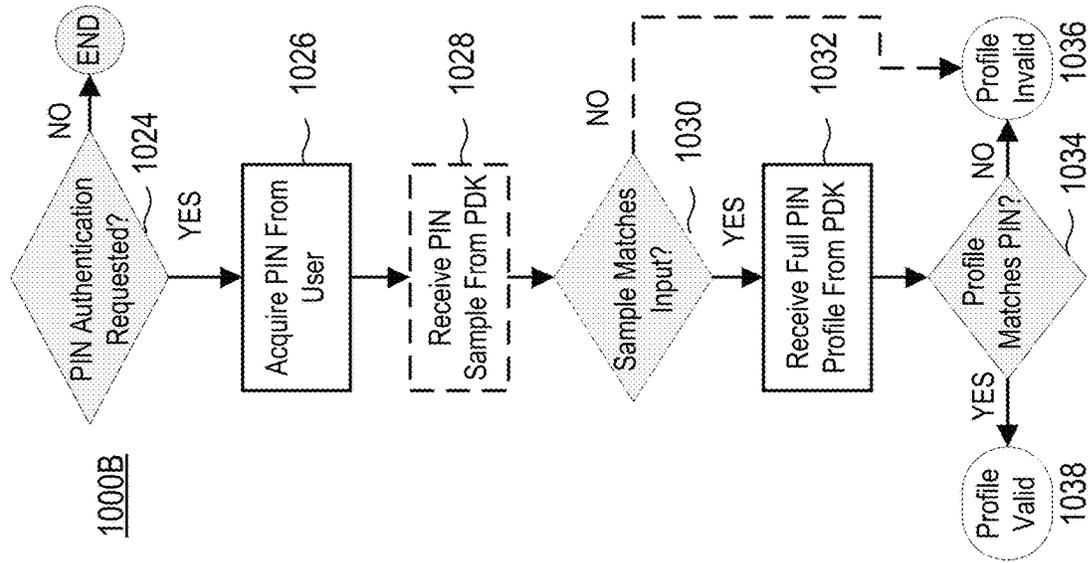


Figure 10B

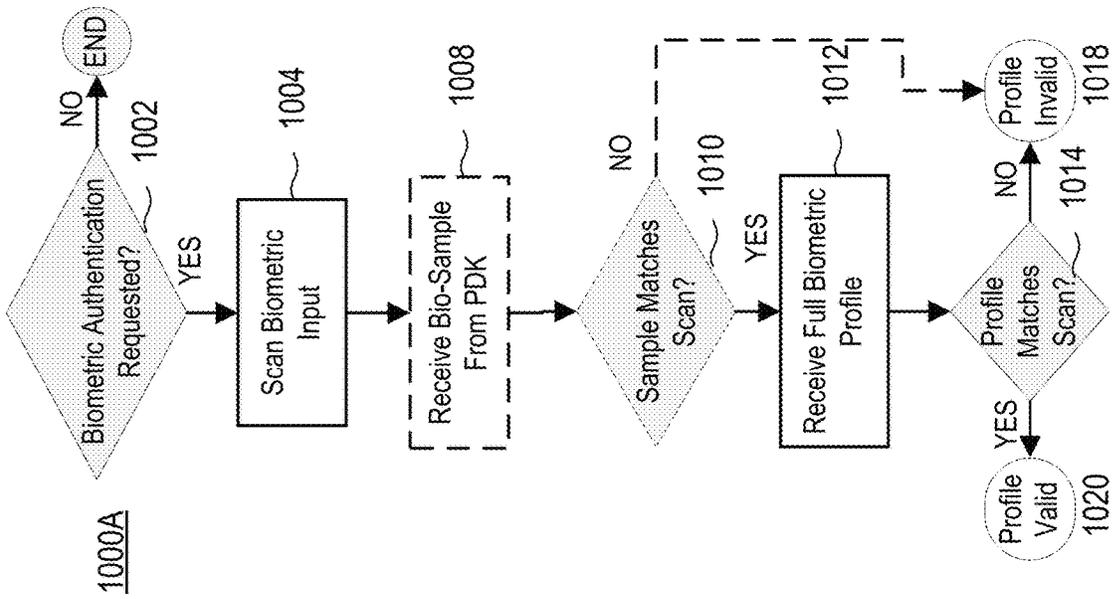


Figure 10A

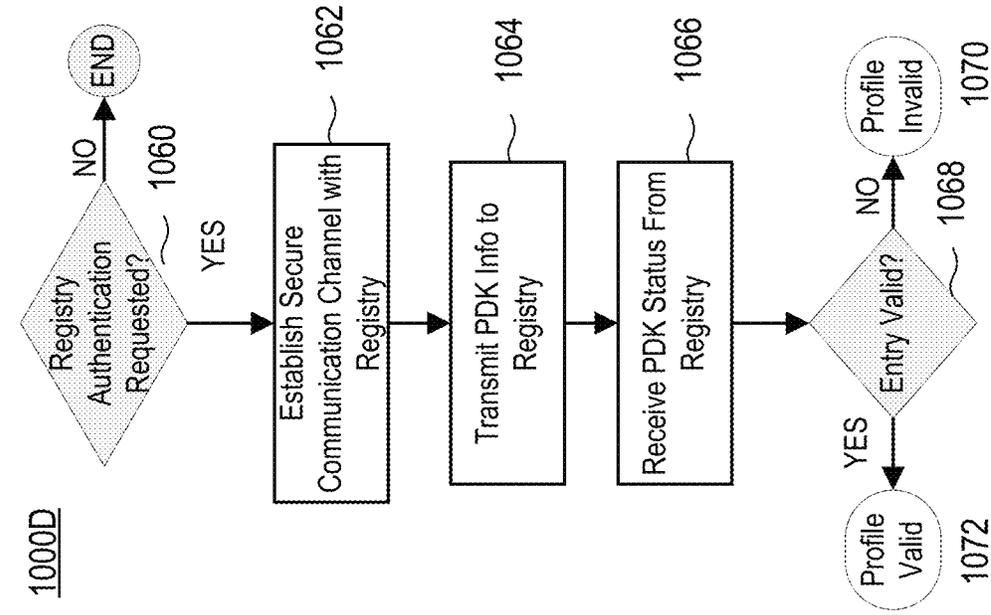


Figure 10D

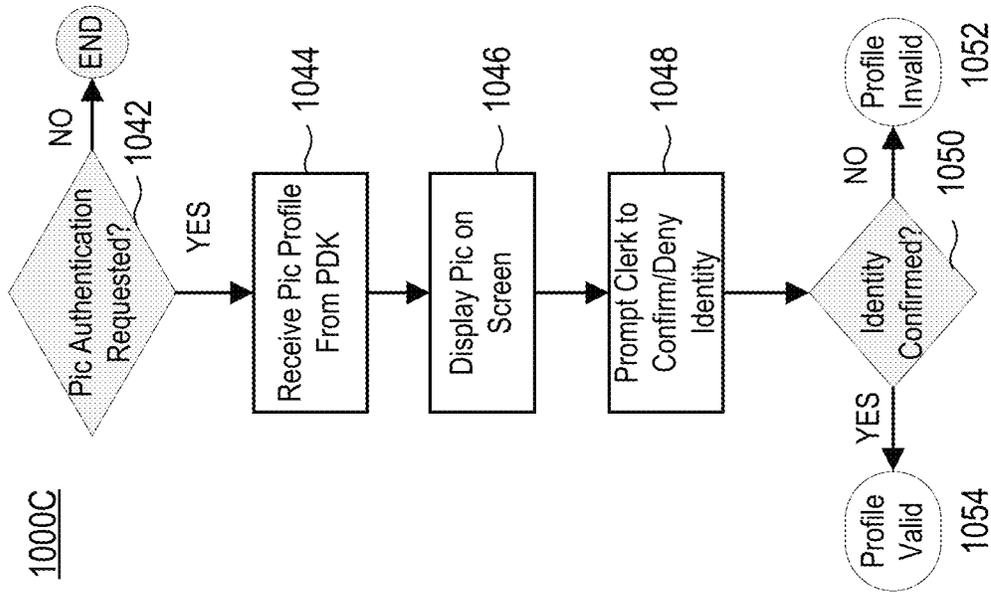


Figure 10C

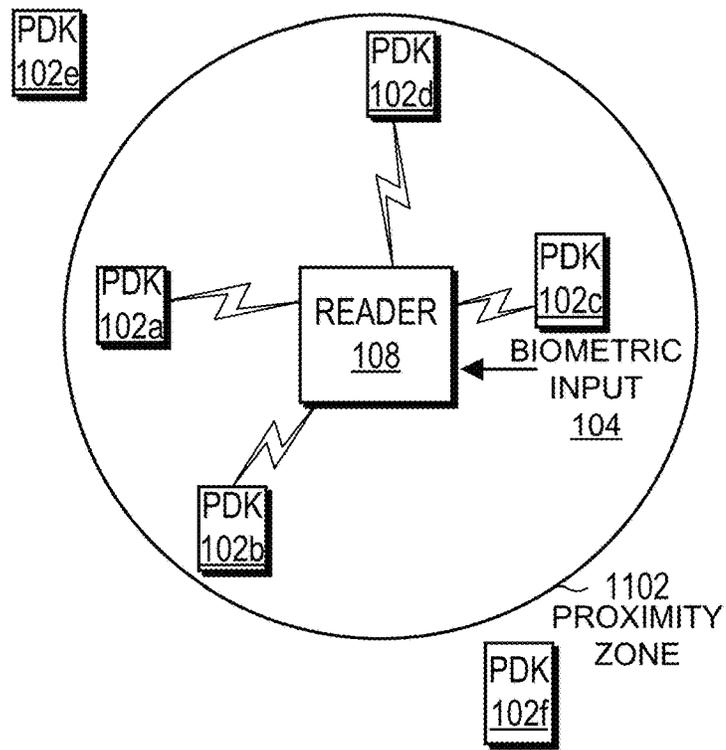


Figure 11A

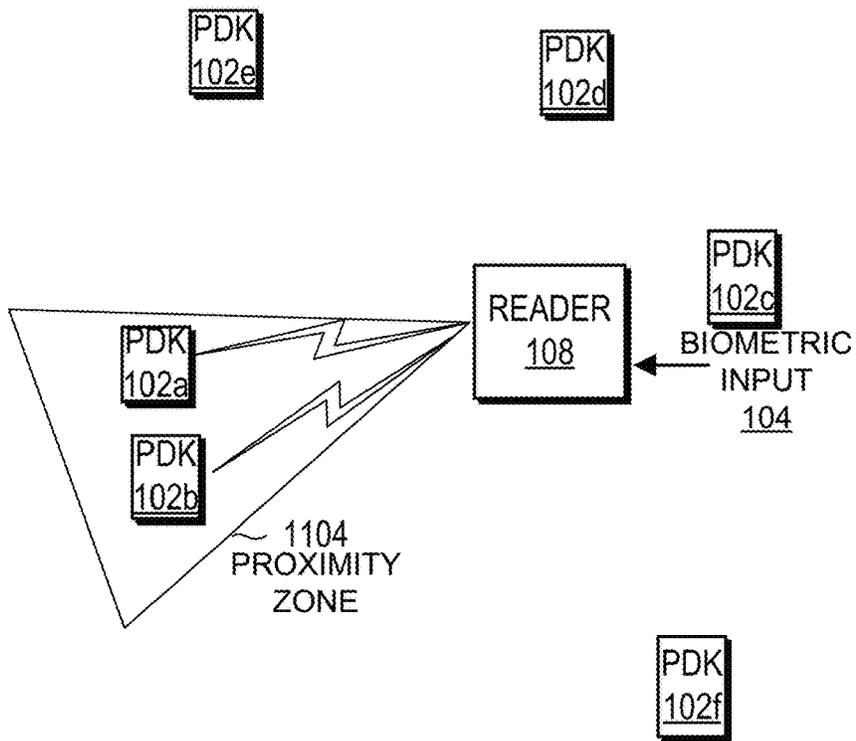


Figure 11B

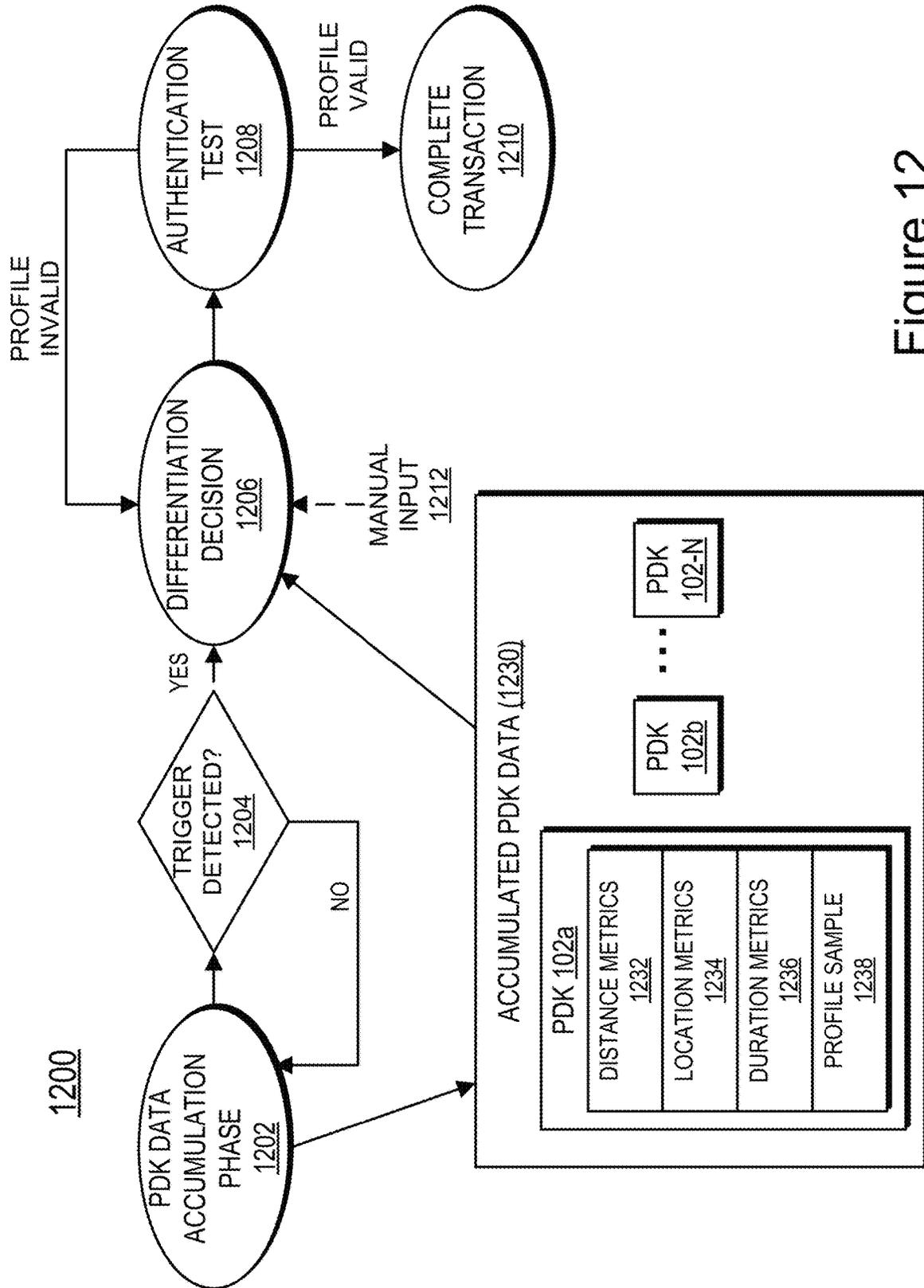


Figure 12

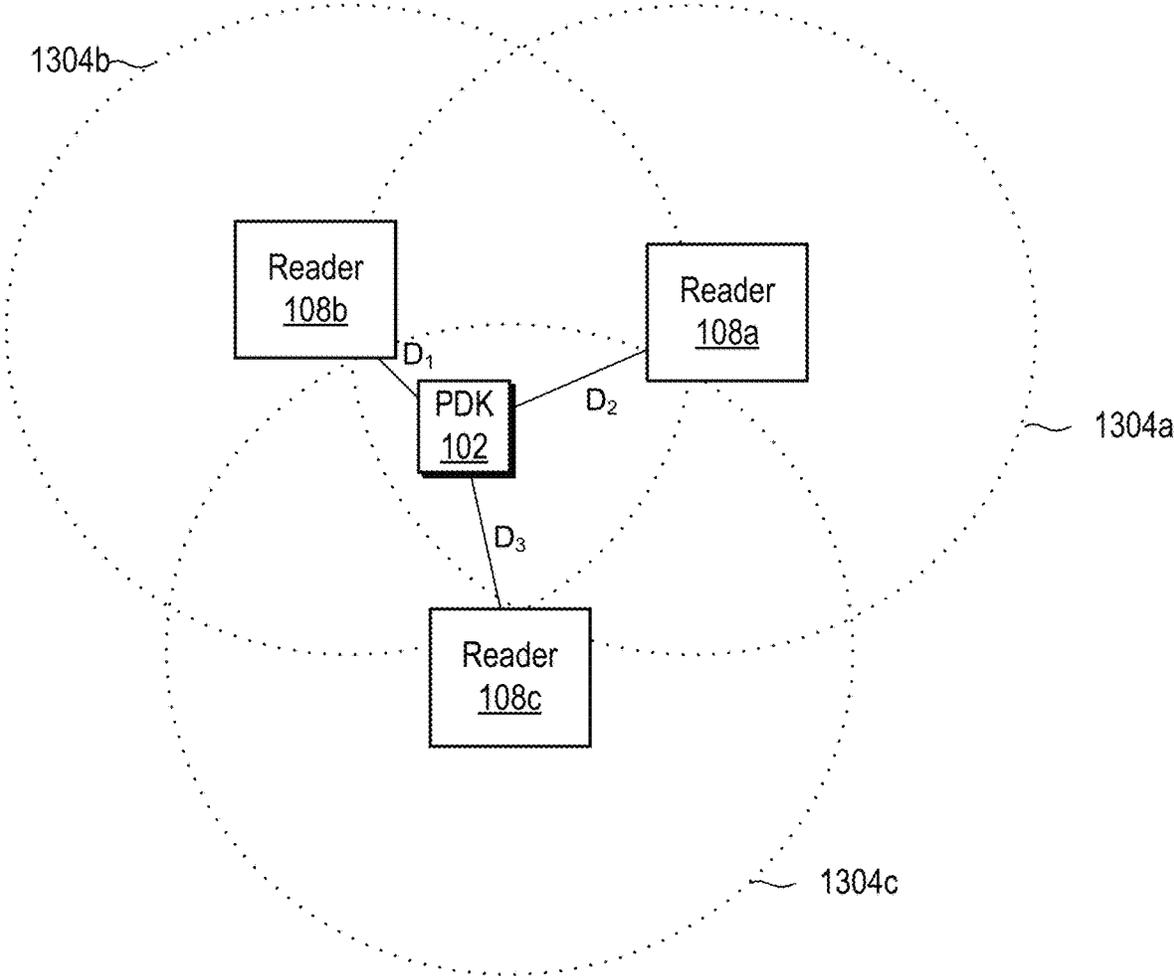


Figure 13

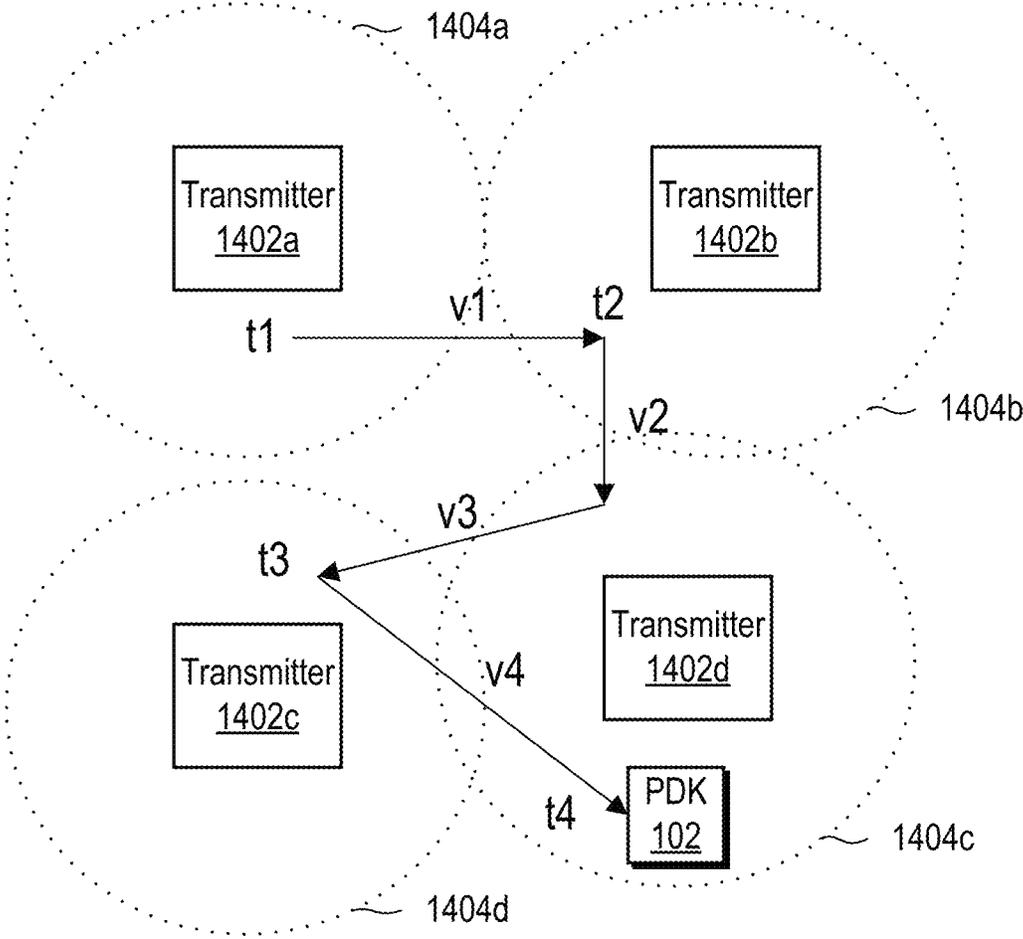


Figure 14

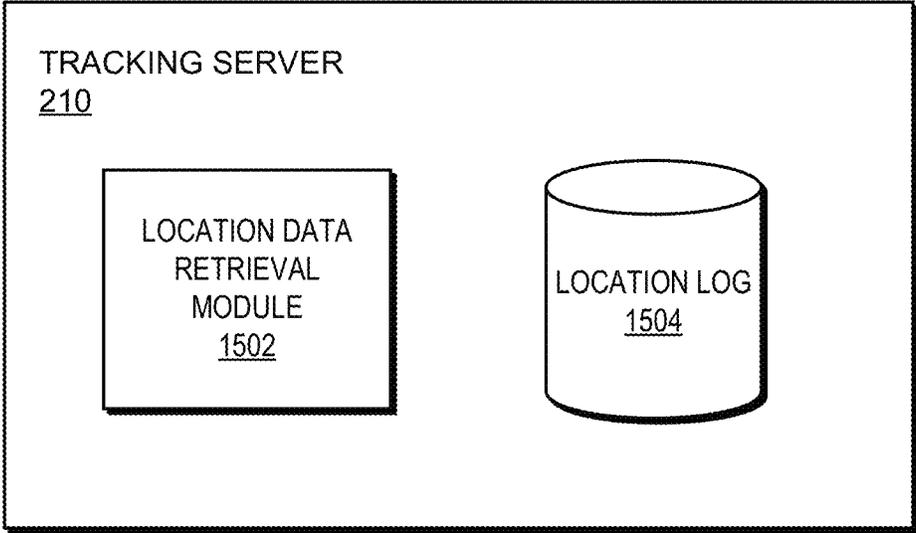


Figure 15

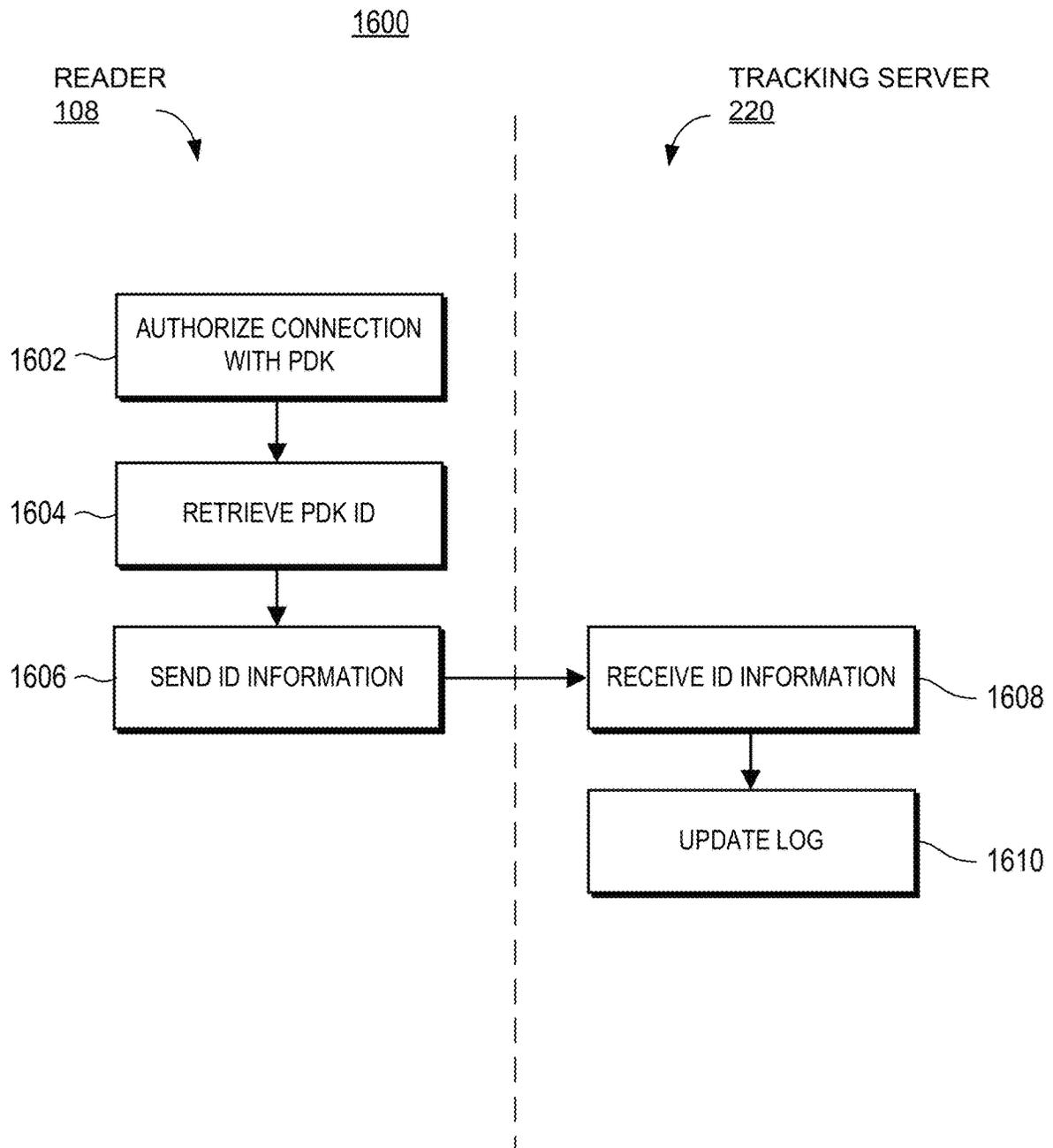


Figure 16A

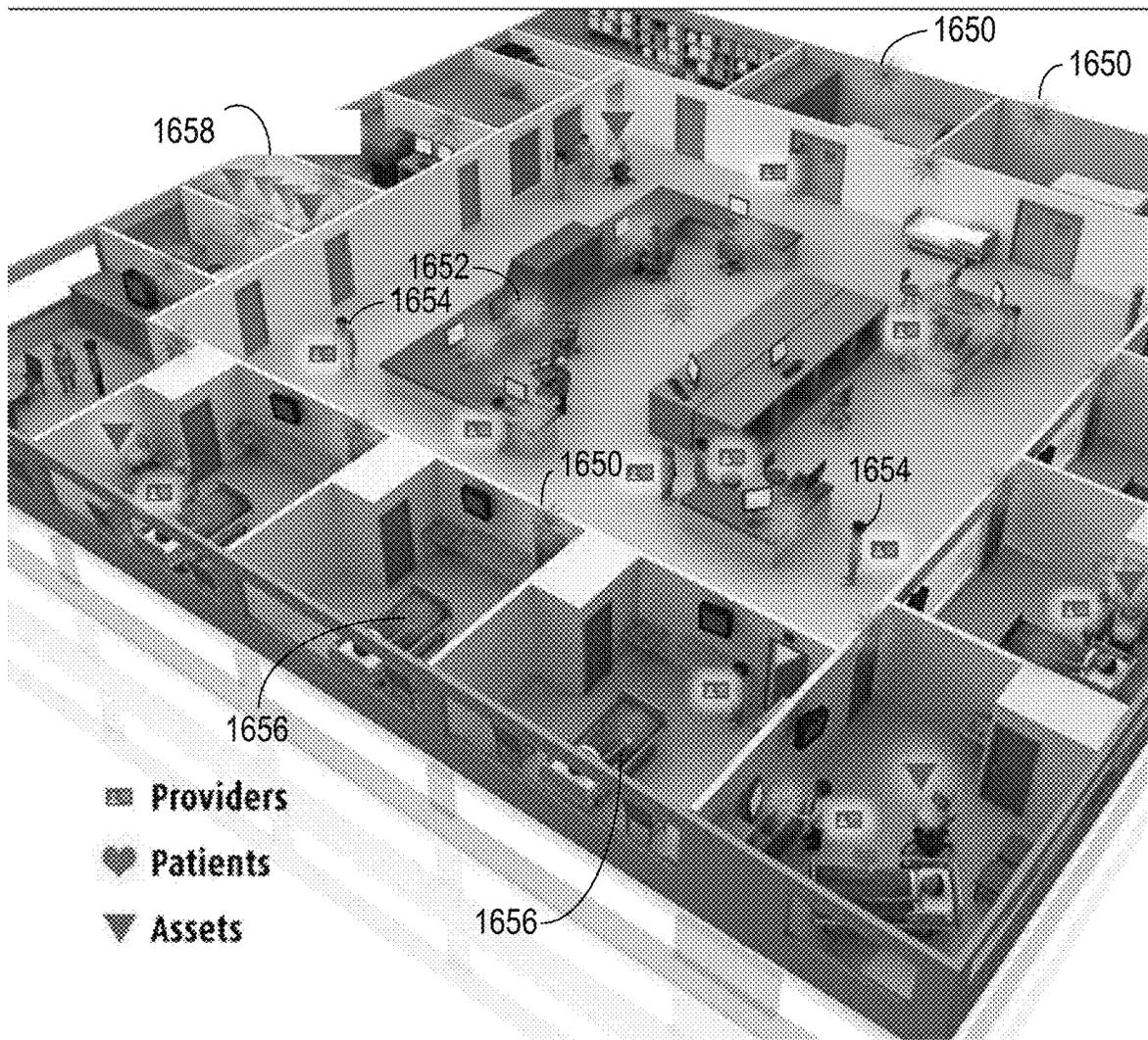


Figure 16B

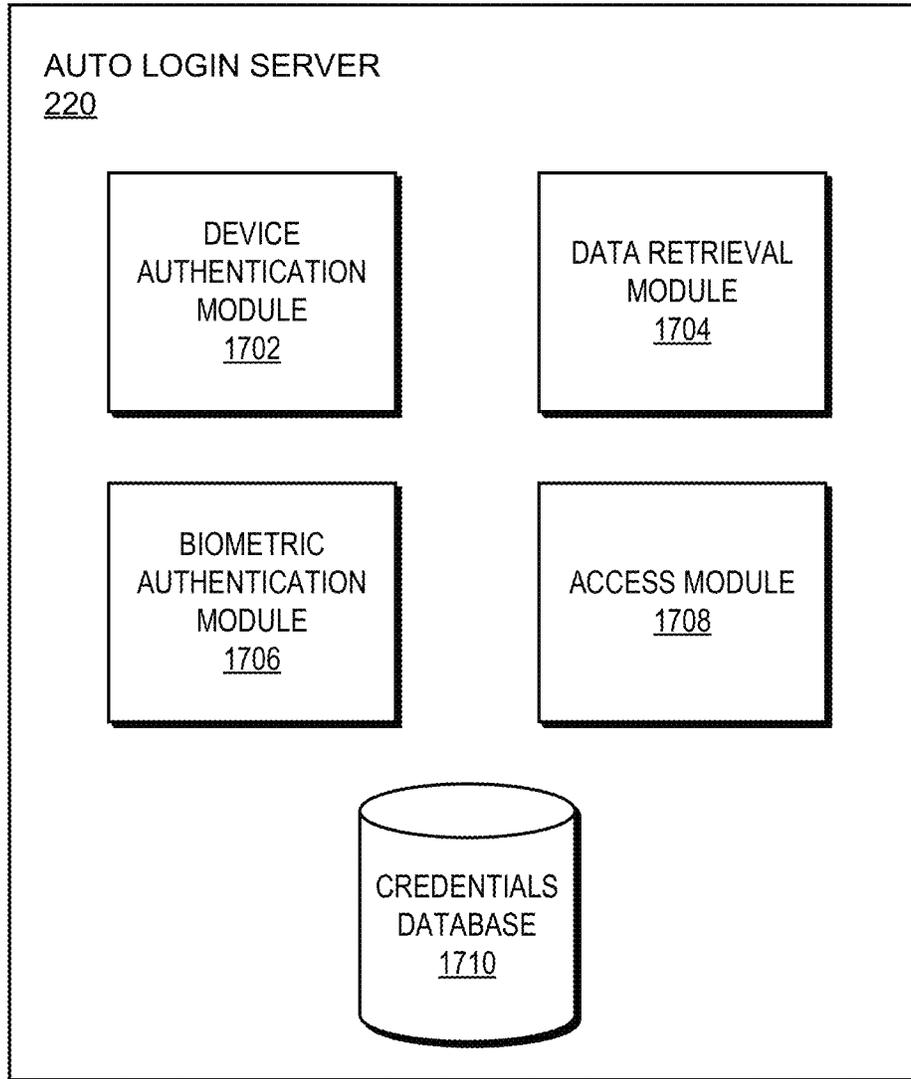


Figure 17

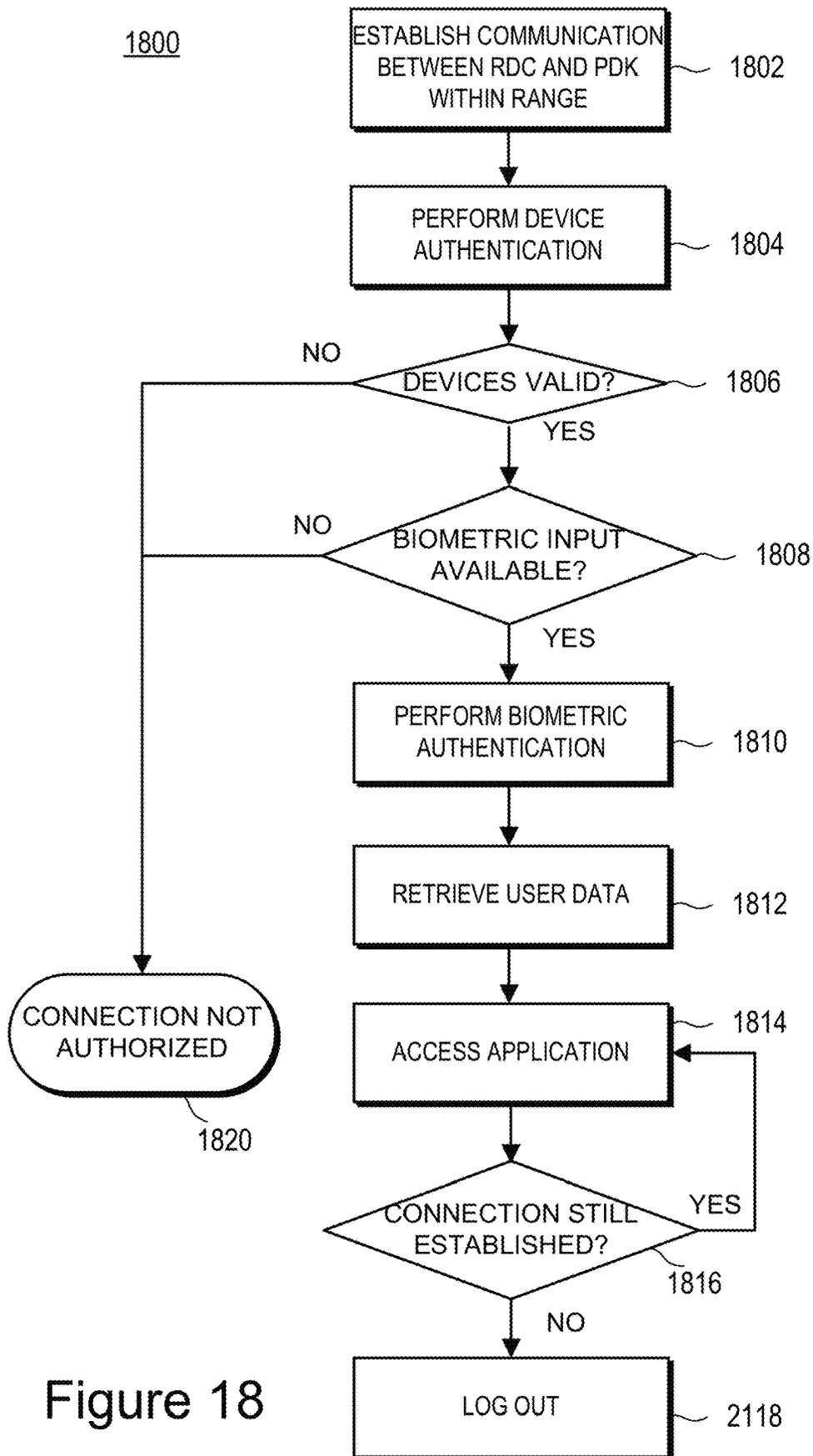


Figure 18

1814

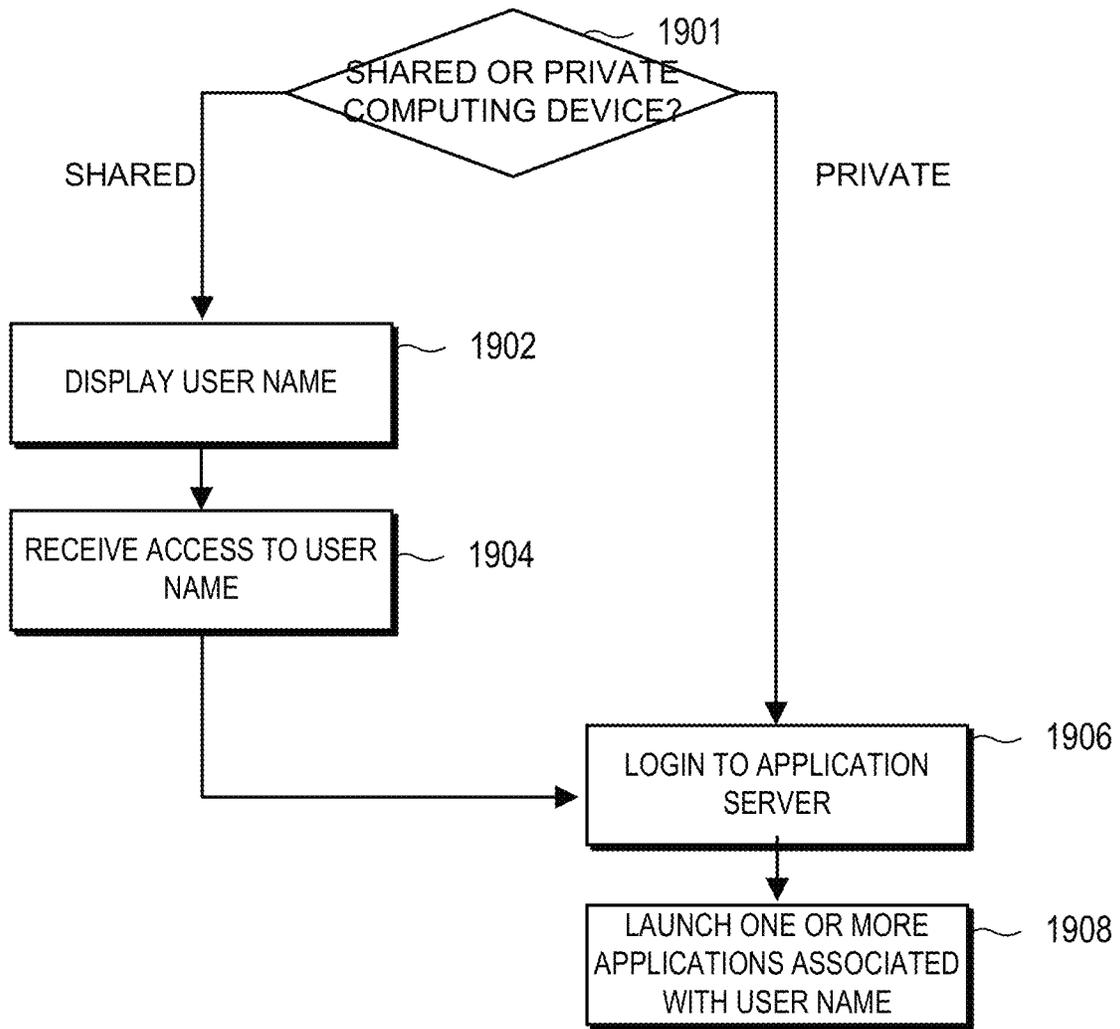


Figure 19

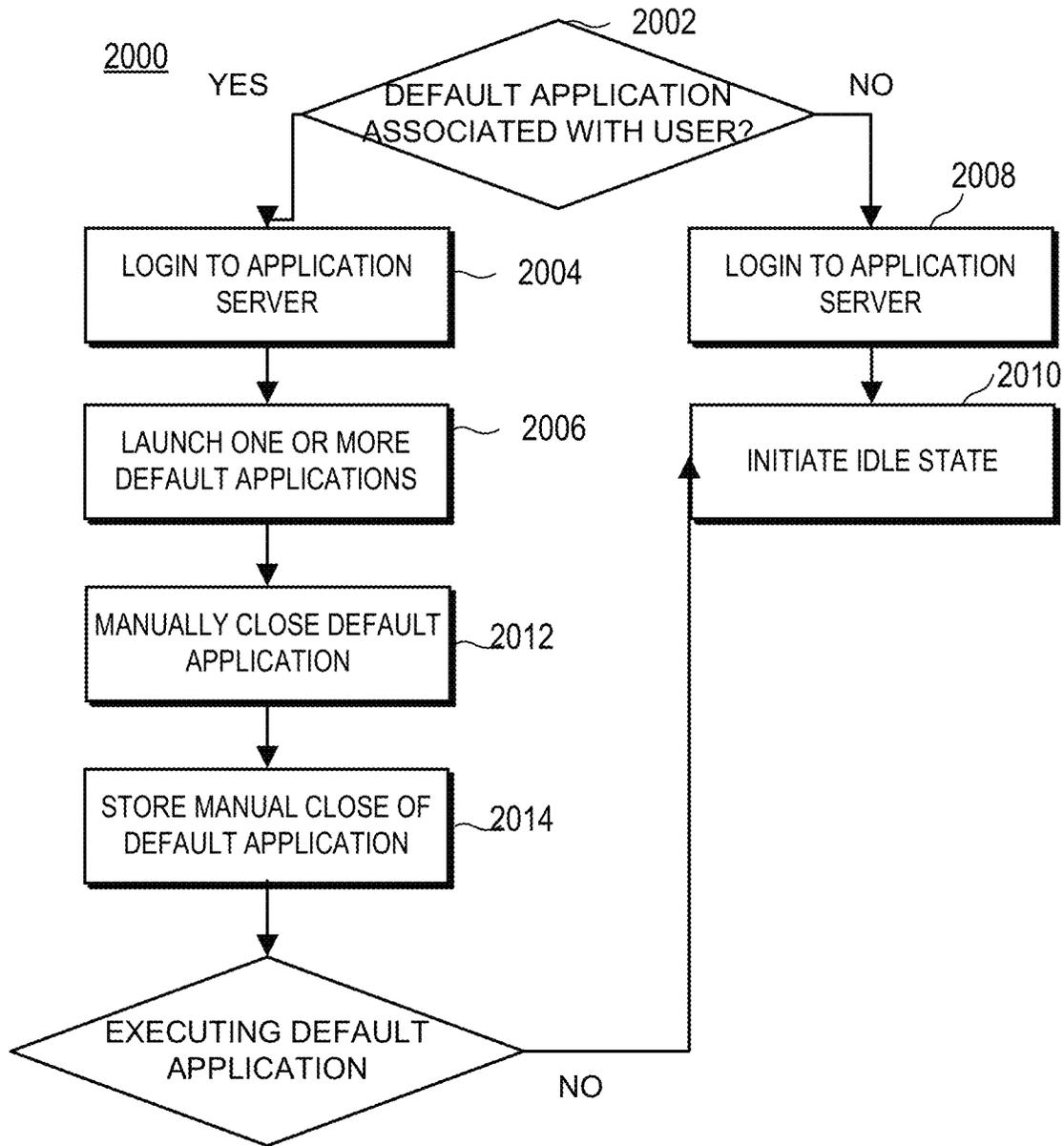


Figure 20

2100

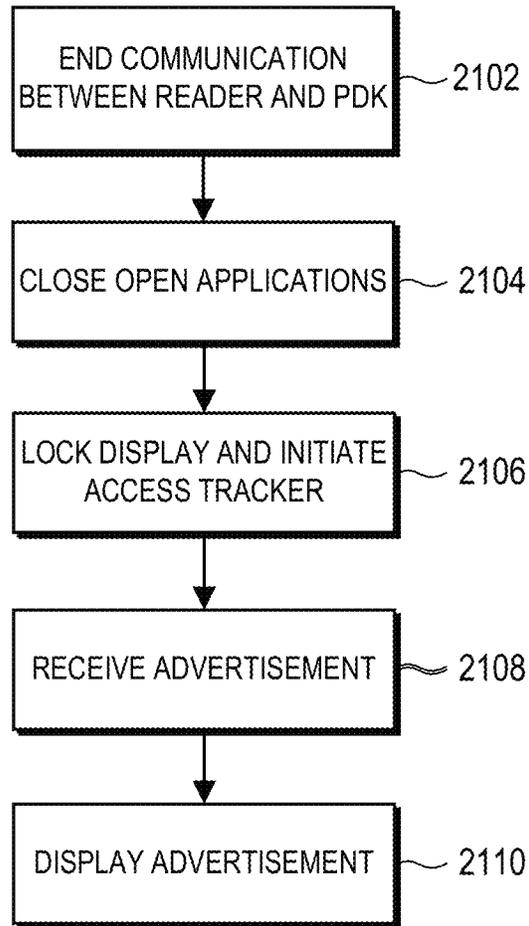


Figure 21

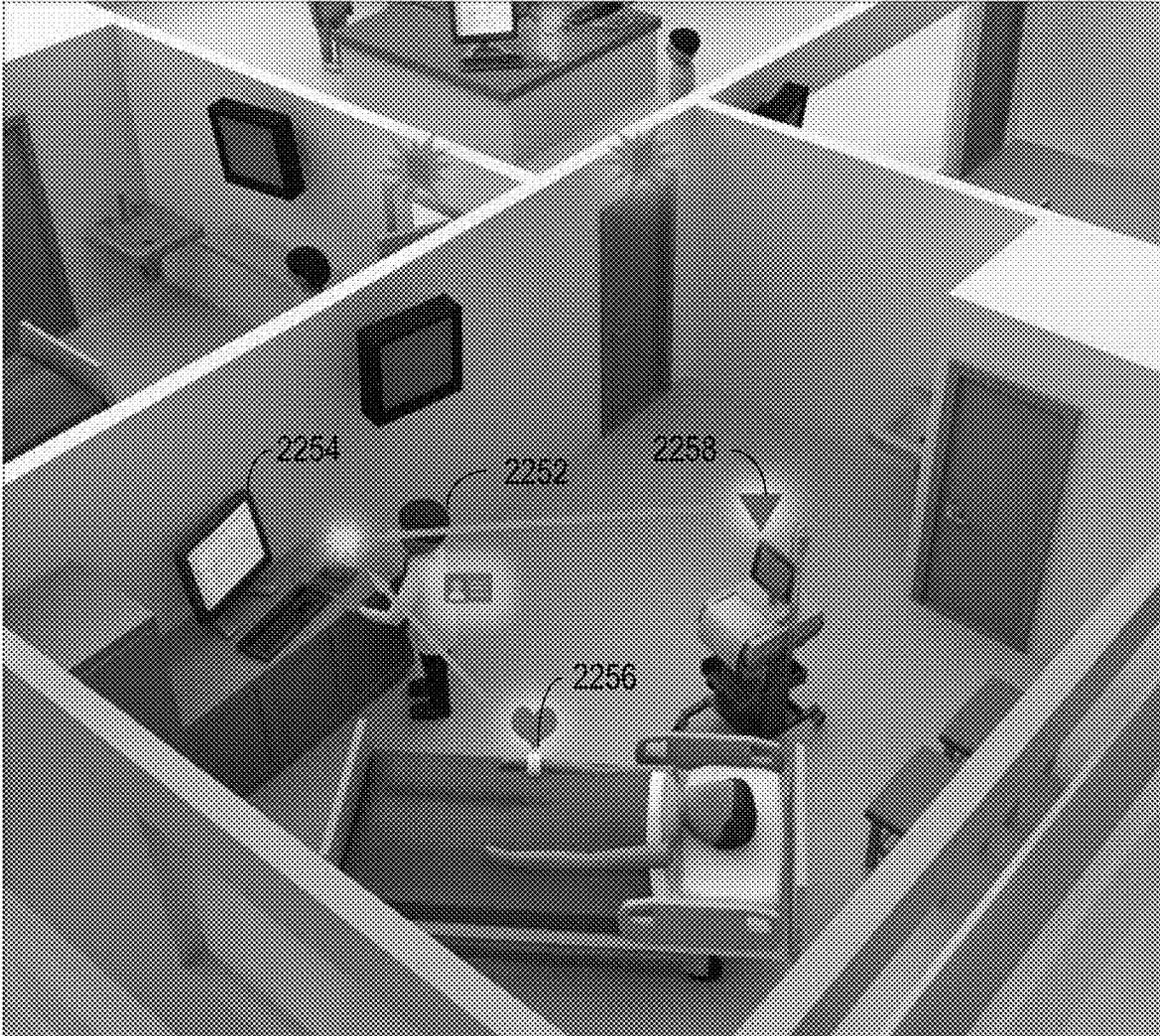


Figure 22

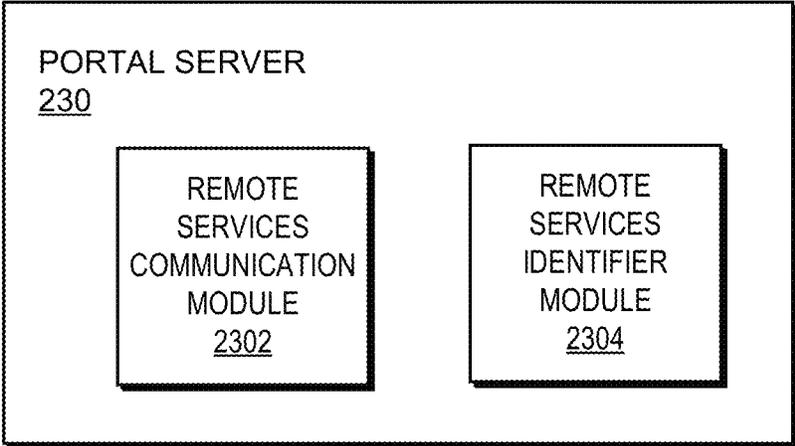


Figure 23

2400

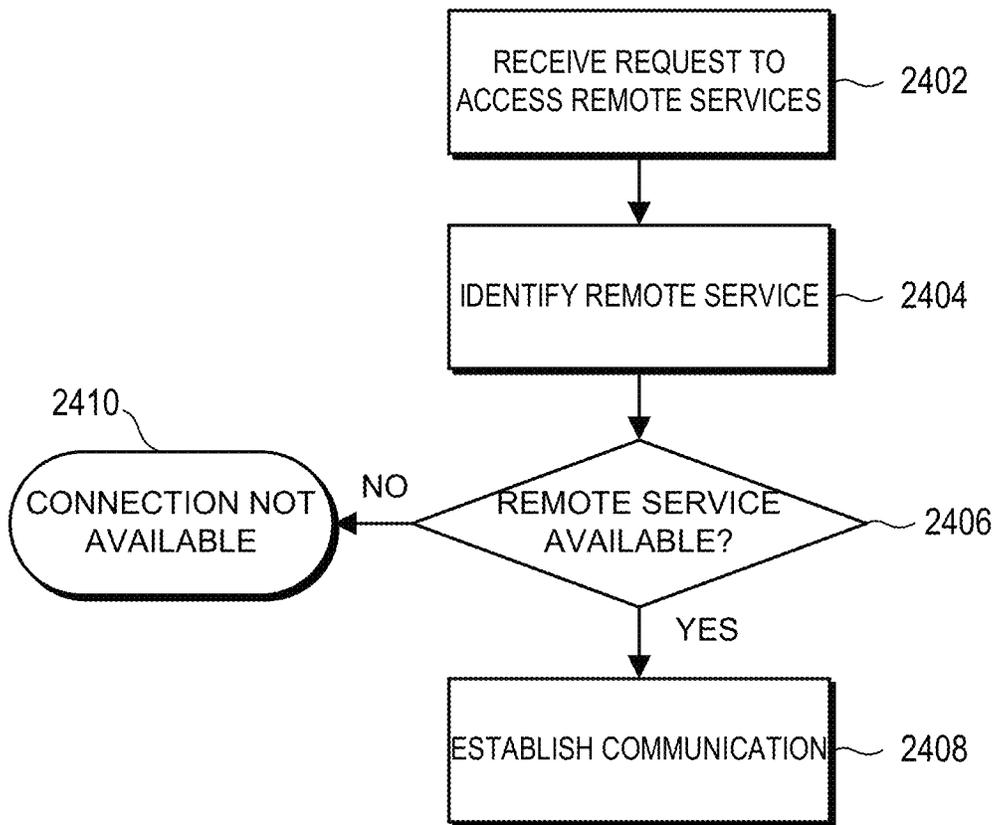


Figure 24

2500

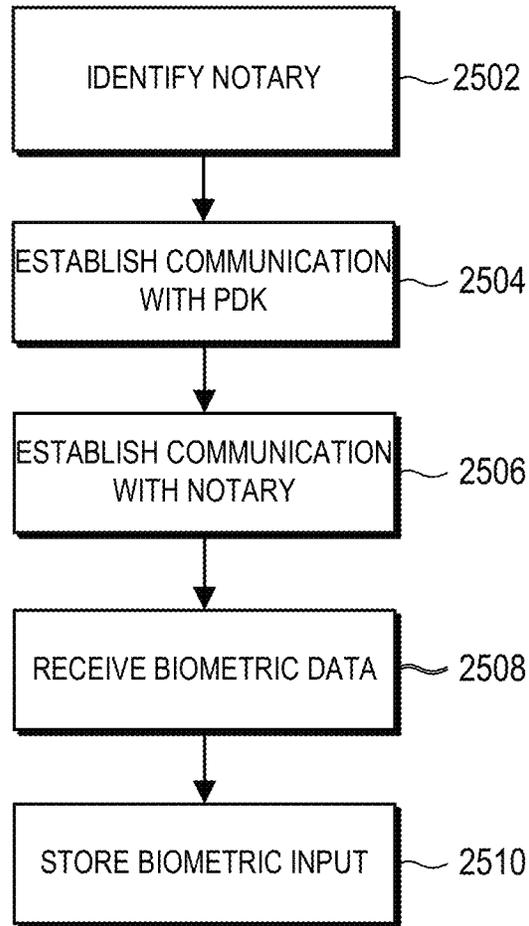


Figure 25

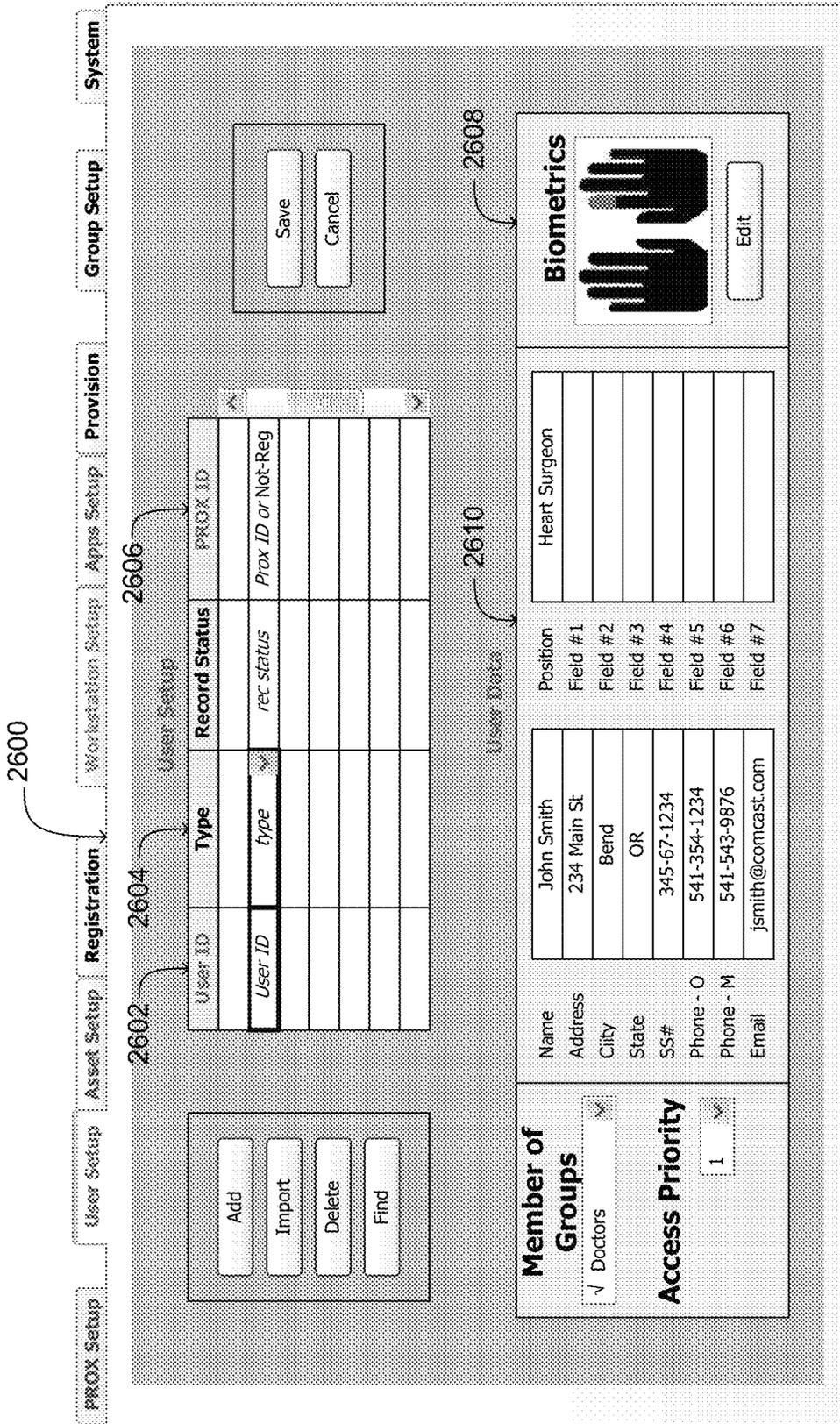


Figure 26

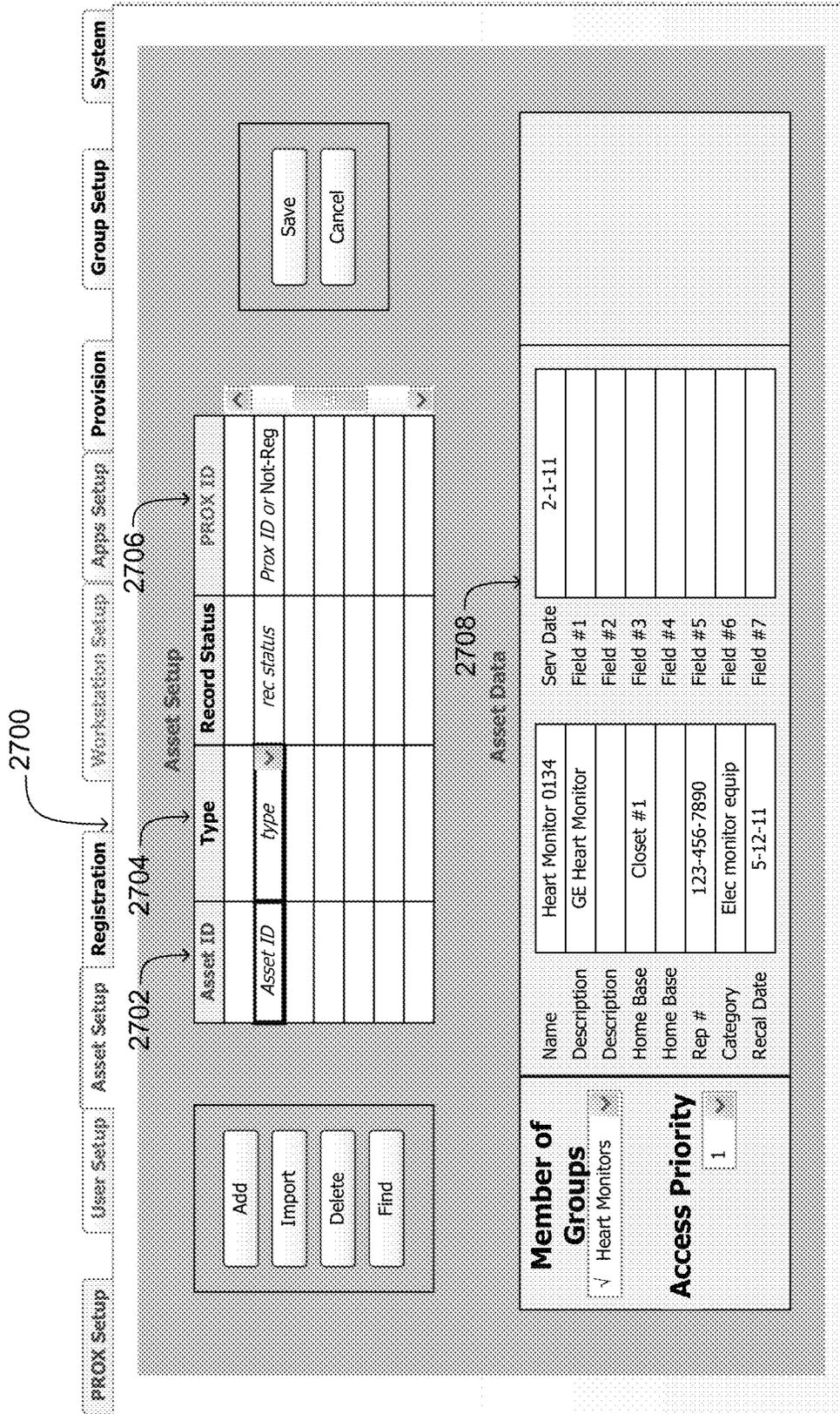


Figure 27

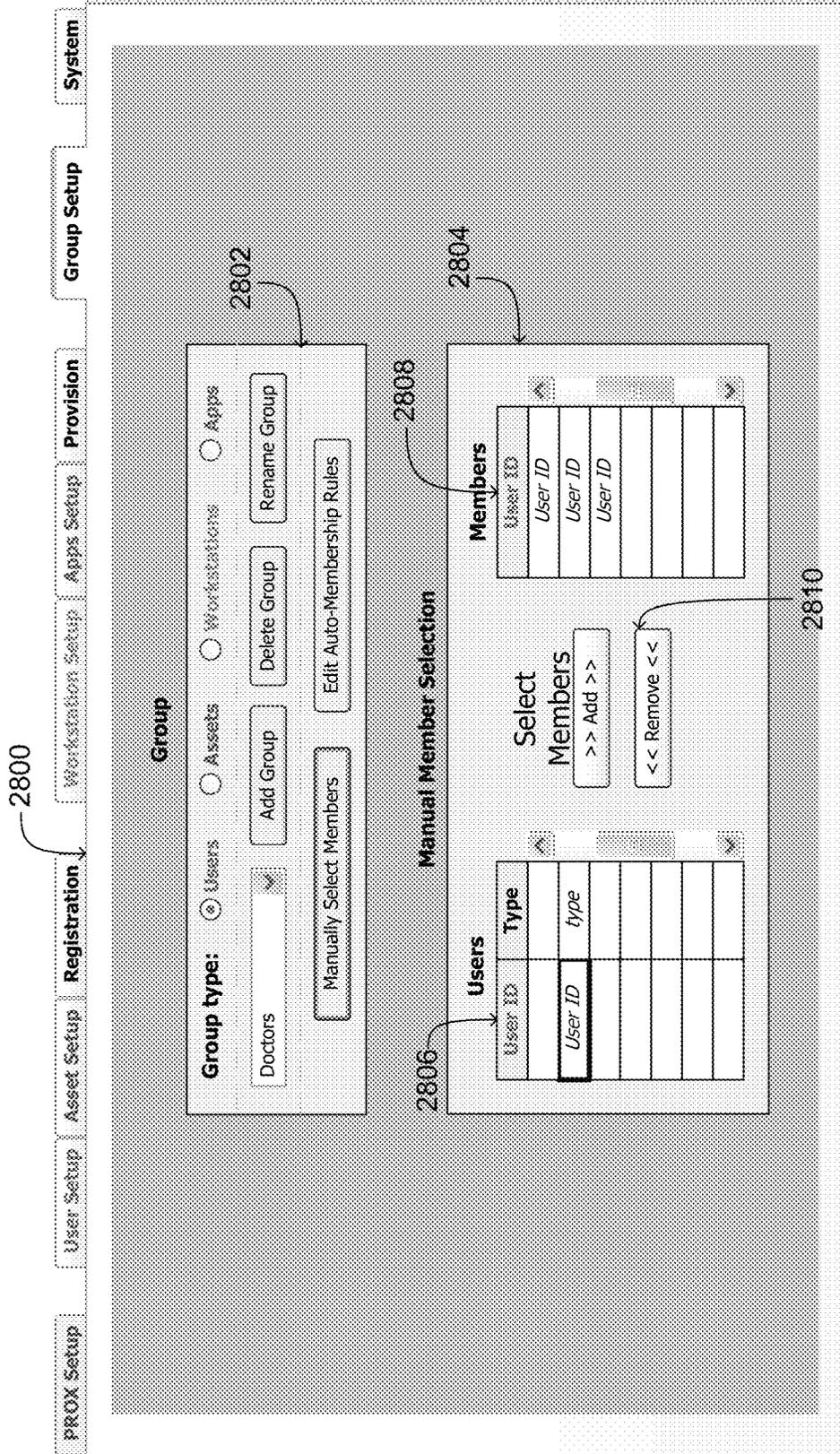


Figure 28

2900

Group

Group type: Users Assets Workstations Ops

Doctors

2802

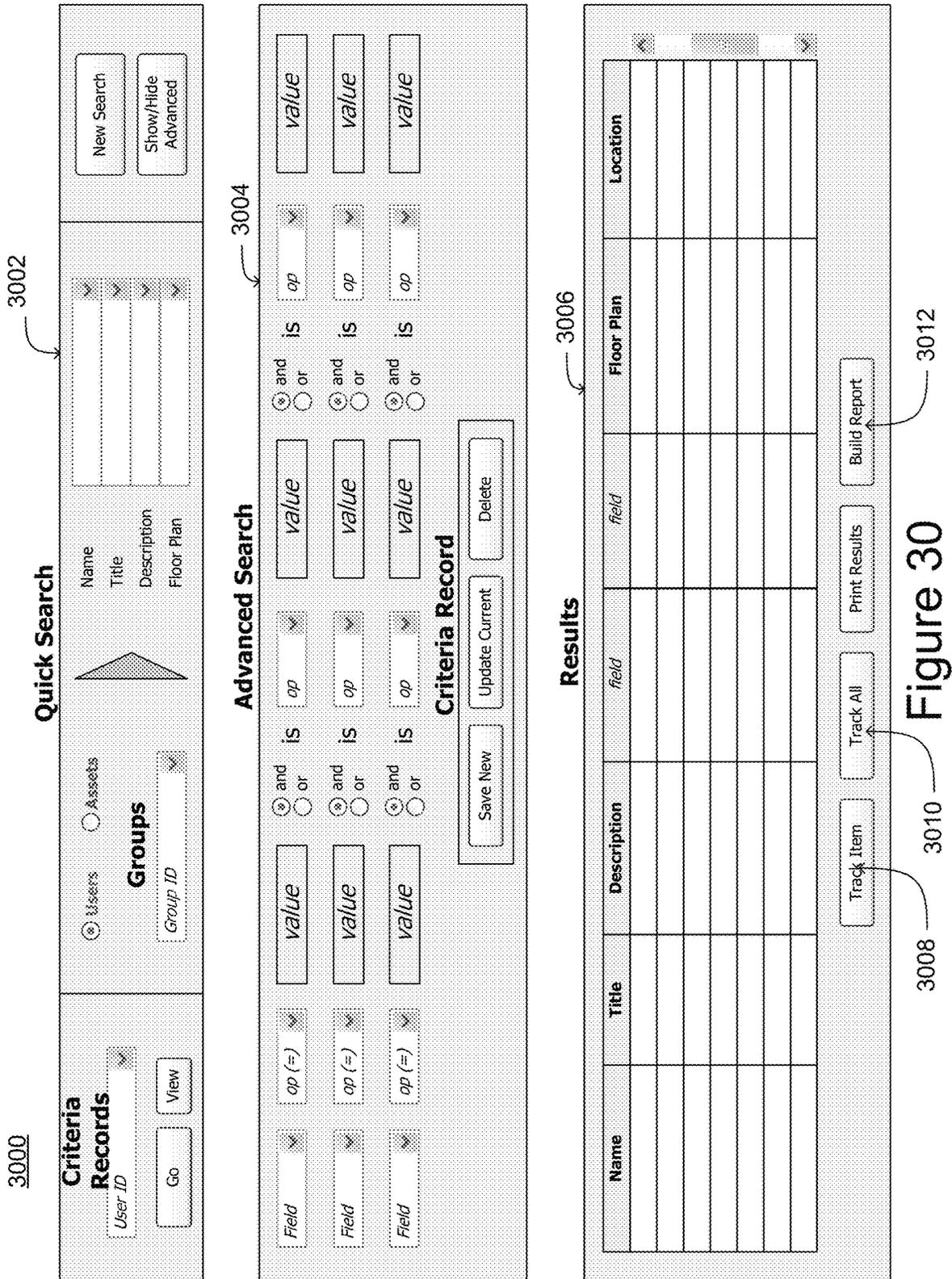
Auto-Membership Rules

<input type="text" value="Field"/>	<input type="text" value="op (=)"/>	<input type="text" value="value"/>	<input checked="" type="radio"/> and <input type="radio"/> or	<input type="text" value="is"/>	<input type="text" value="value"/>	<input checked="" type="radio"/> and <input type="radio"/> or	<input type="text" value="op"/>	<input type="text" value="value"/>
<input type="text" value="Field"/>	<input type="text" value="op (=)"/>	<input type="text" value="value"/>	<input checked="" type="radio"/> and <input type="radio"/> or	<input type="text" value="is"/>	<input type="text" value="value"/>	<input checked="" type="radio"/> and <input type="radio"/> or	<input type="text" value="op"/>	<input type="text" value="value"/>
<input type="text" value="Field"/>	<input type="text" value="op (=)"/>	<input type="text" value="value"/>	<input checked="" type="radio"/> and <input type="radio"/> or	<input type="text" value="is"/>	<input type="text" value="value"/>	<input checked="" type="radio"/> and <input type="radio"/> or	<input type="text" value="op"/>	<input type="text" value="value"/>

Rules

2904

Figure 29



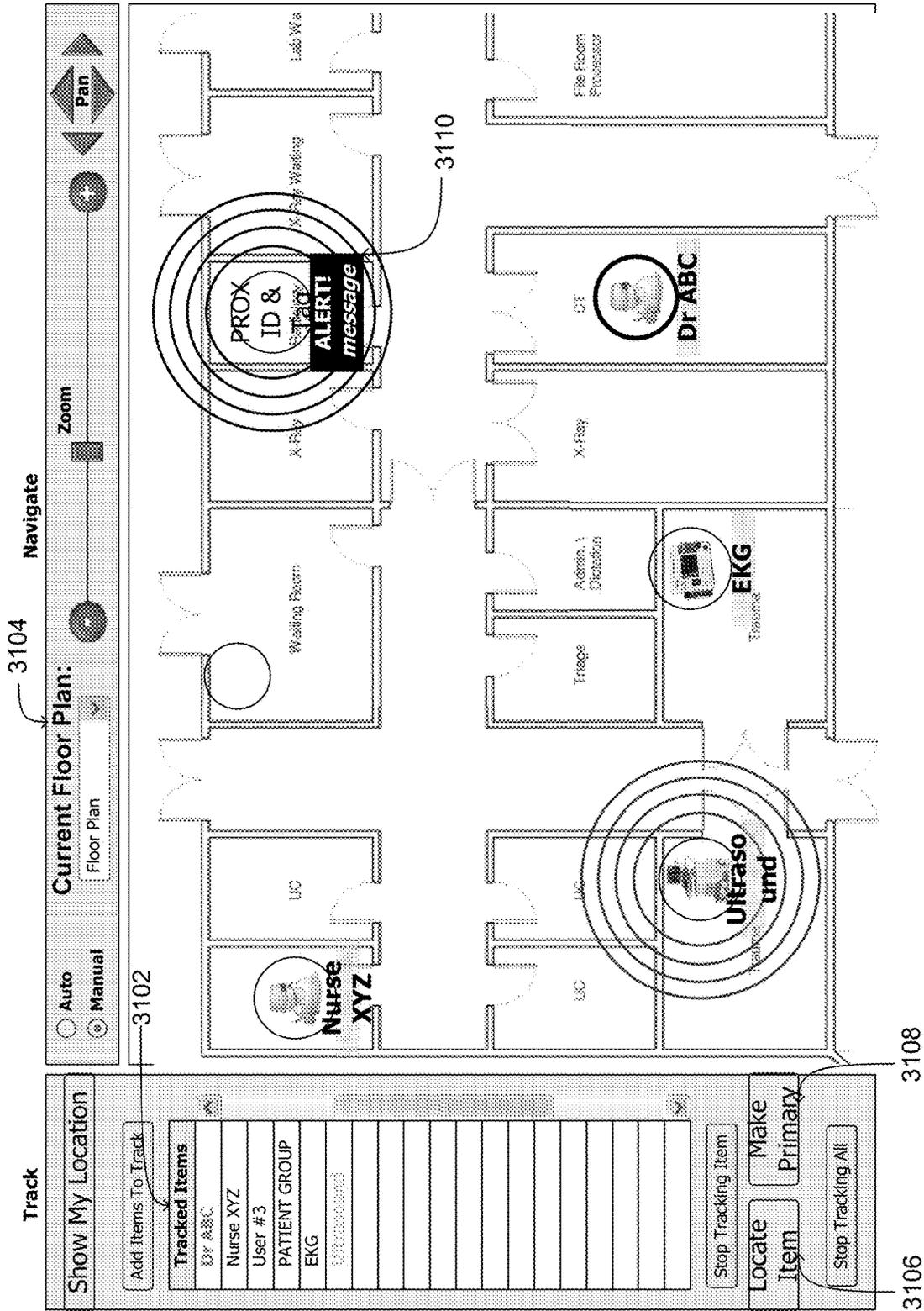


Figure 31

3200

Current Alert List

Name	Description	Source	Trigger
alert name	alert description	monitored item	trigger event

3202

Alert Details

If PROX Sensor Group Group

Identifier

is detected by
 is not detected by
 temperature enters range
 temperature is out of range
 response is lost

-

3204

default

Select	Message Type	Address List	Priority Level
<input checked="" type="checkbox"/>	Visual	user list	1
<input checked="" type="checkbox"/>	Email	address list	1
<input checked="" type="checkbox"/>	SMS	address list	2
<input checked="" type="checkbox"/>	Workstation Message	workstation ID list	2
<input checked="" type="checkbox"/>	Broadcast Message	network ID	3
<input checked="" type="checkbox"/>	Custom	custom interface	4

via:

Figure 32

3300

Current Report List

Name	Description	Form	Type
report name	report description	graphic/text	Report type

Go

Create New Edit Delete

3302

Report Details

1 Select Report Type: report type

2 Select PROX: Criteria Record New Search ... and Make Primary: PROX list

3 Select Zones: All Visited Sensor Group Custom Identifier

4 Select Time Period: yesterday or 00/00/00 thru 00/00/00 00:00 AM/PM 00:00 AM/PM

5 Select Display Options:

<input checked="" type="checkbox"/> Arrival Time	<input checked="" type="checkbox"/> Total PROX Visiting	<input checked="" type="checkbox"/> Total Zones Visited
<input checked="" type="checkbox"/> Departure Time	<input checked="" type="checkbox"/> Total Visits	<input checked="" type="checkbox"/> Total Time of Visits
<input checked="" type="checkbox"/> Time in Zone	<input checked="" type="checkbox"/> Average Visits Per PROX	<input checked="" type="checkbox"/> Average Visits Per Zone
<input checked="" type="checkbox"/> Last Zone Visited	<input checked="" type="checkbox"/> Average Time Per Visit	<input checked="" type="checkbox"/> Average Time Per Visit
<input checked="" type="checkbox"/> Time Between Zones	<input checked="" type="checkbox"/> Average Time Between Zones	<input checked="" type="checkbox"/> Average Time Between Zones
	<input checked="" type="checkbox"/> Most Common Previous Zone	<input checked="" type="checkbox"/> Most Common Previous Zone
		<input type="checkbox"/> Total Time Out of Coverage

Sub-Totals Report Totals (Zone focus) Report Totals (PROX focus)

Save New Update Current Clear

3304

Figure 33

PROXIMITY-BASED SYSTEM FOR OBJECT TRACKING

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of and claims priority to U.S. application Ser. No. 15/077,745, filed Mar. 22, 2016, titled "Proximity-Based System for Object Tracking," which claims priority to U.S. application Ser. No. 14/534,045, filed Nov. 5, 2014, which claims priority to U.S. application Ser. No. 13/183,420, filed Jul. 14, 2011, titled "Proximity-Based System for Object Tracking," and U.S. application Ser. No. 13/183,354, filed Jul. 14, 2011, titled "Proximity-Based System for Automatic Application Initialization," which both claim the benefit of U.S. Patent Application No. 61/364,790, filed Jul. 15, 2010, the entireties of which are hereby incorporated by reference.

Applicants hereby notify the USPTO that the claims of the present application are different from those of the aforementioned related application. Therefore, Applicant rescinds any disclaimer of claim scope made in the parent application or any other predecessor application in relation to the present application. The Examiner is therefore advised that any such disclaimer and the cited reference that it was made to avoid may need to be revisited at this time. Furthermore, the Examiner is also reminded that any disclaimer made in the present application should not be read into or against the parent application or any other related application.

BACKGROUND OF THE INVENTION

1. Field of Art

This disclosure generally relates to the field of radio frequency identification (RFID) and electronic authentication, and more specifically, to systems and methods for object tracking.

2. Description of the Related Art

Optimizing patient care is an ever-changing and challenging endeavor. Ensuring quality patient care that is safe, efficient and cost-effective is very important to patients, as well as healthcare providers. Conventional technologies used in the healthcare industry for aiding provider patient care, monitoring patient treatment, receiving and retrieving patient data and monitoring provider activity have not yet provided optimal features to meet these needs. Recently, software application systems have been developed in an attempt to improve patient care and provider performance.

Currently, many healthcare facilities utilize electronic software and applications to securely store and efficiently access private patient information. In many healthcare institutions, healthcare providers access patient electronic records with authorized entry into the healthcare software application system. In most conventional systems, providers are provided with a unique user name and password that they must enter into a system each time they need to access patient information. Further, when a healthcare provider is done accessing patient records, the healthcare provider must log out of the system to ensure that unauthorized use does not occur. The process of logging in and logging off each time may prove to be quite time-consuming given the number of patients a provider visits in a given day.

Another problem for many healthcare facilities is making sure that equipment is deployed in a manner that maximizes

their usage and availability. For example, in many hospitals the location of equipment is not tracked and monitored other than during an annual equipment inventory. Thus, healthcare providers may not be aware of the precise location of equipment or know when equipment is currently in use. Thus, conventional methods provided limited ability to track the location of equipment.

BRIEF SUMMARY OF THE INVENTION

A system and method provides for tracking of an object. A personal digital key (PDK) includes a profile uniquely associated with the object. A reader is configured to wirelessly communicate with the PDK. The reader receives profile information from the PDK. A tracking server is configured to communicate with the reader. The tracking server is configured to track and log location information of the PDK associated with the object. The location information is received from the reader. A computing device is configured to communicate with the reader and the tracking server, the computing device configured to display data on a display device responsive to receiving the location information from the reader.

A method for tracking an object includes receiving a search query. The search query includes at least one identifier associated with the object. The object is carrying a personal digital key (PDK) and the PDK is associated with the object and wirelessly communicating with a receiver/decoder circuit (RDC). The method also includes retrieving information from a tracking server. The information includes location information of the PDK associated with the object. The method also includes generating a graphical representation of a floorplan of a monitored area and generating a graphical representation of a location of an object on the floorplan.

The features and advantages described in the specification are not all inclusive and, in particular, many additional features and advantages will be apparent to one of ordinary skill in the art in view of the drawings, specification, and claims. Moreover, it should be noted that the language used in the specification has been principally selected for readability and instructional purposes, and may not have been selected to delineate or circumscribe the disclosed subject matter.

BRIEF DESCRIPTION OF DRAWINGS

The disclosed embodiments have other advantages and features which will be more readily apparent from the detailed description, the appended claims, and the accompanying figures (or drawings). A brief introduction of the figures is below.

FIG. 1 is a block diagram illustrating a system for securely authenticating an individual for accessing data or one or more applications in accordance with the present invention.

FIG. 2 is a block diagram illustrating one embodiment of a local services module in accordance with the present invention.

FIG. 3 is a block diagram illustrating one embodiment of a Personal Digital Key (PDK) in accordance with the present invention.

FIG. 4 is a block diagram illustrating one embodiment of a biometric reader of a PDK in accordance with the present invention.

FIG. 5 is a block diagram illustrating one embodiment of a reader in accordance with the present invention.

FIG. 6 is a block diagram illustrating one embodiment of a computing device in accordance with the present invention.

FIG. 7 is a flowchart of a method for authorizing a communication connection using secure authentication in accordance with the present invention.

FIG. 8 is a flowchart of a method for device authentication by a reader in accordance with the present invention.

FIG. 9 is a flowchart of a method for profile authentication by a reader in accordance with the present invention.

FIG. 10A is a flowchart of a method for biometric authentication in accordance with the present invention.

FIG. 10B is a flowchart of a method for profile testing using a personal identification number in accordance with the present invention.

FIG. 10C is a flowchart of a method for profile testing using a picture profile in accordance with the present invention.

FIG. 10D is a flowchart of a method for profile testing using a private or central registry in accordance with the present invention.

FIG. 11A illustrates an example scenario of a reader operating with multiple PDKs in its proximity zone in accordance with the present invention.

FIG. 11B illustrates an example scenario of operation of a reader with a directional proximity zone in an environment with multiple PDKs in accordance with the present invention.

FIG. 12 is a flowchart of a method for differentiating between multiple PDKs within the proximity zone of a reader in accordance with the present invention.

FIG. 13 is a block diagram of a system for estimating location of a PDK using coordinate triangulation in accordance with the present invention.

FIG. 14 is a block diagram of an alternative system for location tracking of a PDK in accordance with the present invention.

FIG. 15 is a block diagram of a tracking server in accordance with the present invention.

FIG. 16A is a flowchart of a method for tracking assets or users in accordance with the present invention.

FIG. 16B is a graphical representation illustrating an example where patient, provider and equipment tracking is provided within a healthcare facility

FIG. 17 is a block diagram of an auto login server in accordance with the present invention.

FIG. 18 is a flowchart of a method for automatic login of a user in accordance with the present invention.

FIG. 19 is a flowchart of a method for automatically allowing access to one or more applications in accordance with the present invention.

FIG. 20 is a flowchart of a method for identifying one or more applications launched when a user is within the proximity zone of a reader in accordance with the present invention.

FIG. 21 is a flowchart of a method for locking a computing device coupled to a reader responsive to a PDK exiting the proximity zone of the reader in accordance with the present invention.

FIG. 22 is a graphical representation of one embodiment of automatic login of users.

FIG. 23 is a block diagram of a portal server in accordance with the present invention.

FIG. 24 is a flowchart of a method for communicating with remote services provided by a third party site in accordance with the present invention.

FIG. 25 is a flow chart of a method for initially storing data on a PDK in accordance with the present invention.

FIG. 26 is an example user interface for configuring user information associated with a PDK in accordance with the present invention.

FIG. 27 is an example user interface for configuring asset information associated with a PDK in accordance with the present invention.

FIG. 28 is an example user interface for manually identifying assets or users included in a group in accordance with the present invention.

FIG. 29 is an example user interface for automatically identifying assets or users included in a group in accordance with the present invention.

FIG. 30 is an example user interface for tracking a user or an asset associated with a PDK in accordance with the present invention.

FIG. 31 is an example user interface for identifying the location of a tracked user or asset associated with a PDK in accordance with the present invention.

FIG. 32 is an example user interface for describing an alert for a tracked user or asset in accordance with the present invention.

FIG. 33 is an example user interface for describing a report for a tracked user or asset in accordance with the present invention.

The figures depict various embodiments of the present invention for purposes of illustration only. One skilled in the art will readily recognize from the following discussion that alternative embodiments of the structures and methods illustrated herein may be employed without departing from the principles of the invention described herein.

DETAILED DESCRIPTION

A system and method for providing automatic access to applications or data while maintaining application or data security are described. In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the invention. It will be apparent, however, to one skilled in the art that the invention can be practiced without these specific details. In other instances, structures and devices are shown in block diagram form in order to avoid obscuring the invention.

Reference in the specification to “one embodiment” or “an embodiment” means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention. The appearances of the phrase “in one embodiment” in various places in the specification are not necessarily all referring to the same embodiment.

Some portions of the detailed descriptions that follow are presented in terms of algorithms and symbolic representations of operations on data bits within a computer memory. These algorithmic descriptions and representations are the means used by those skilled in the data processing arts to most effectively convey the substance of their work to others skilled in the art. An algorithm is here, and generally, conceived to be a self consistent sequence of steps leading to a desired result. The steps are those requiring physical manipulations of physical quantities. Usually, though not necessarily, these quantities take the form of electrical or magnetic signals capable of being stored, transferred, combined, compared, and otherwise manipulated. It has proven convenient at times, principally for reasons of common

usage, to refer to these signals as bits, values, elements, symbols, characters, terms, numbers or the like.

It should be borne in mind, however, that all of these and similar terms are to be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities. Unless specifically stated otherwise as apparent from the following discussion, it is appreciated that throughout the description, discussions utilizing terms such as “processing” or “computing” or “calculating” or “determining” or “displaying” or the like, refer to the action and processes of a computer system, or similar electronic computing device, that manipulates and transforms data represented as physical (electronic) quantities within the computer system’s registers and memories into other data similarly represented as physical quantities within the computer system memories or registers or other such information storage, transmission or display devices.

The specification also relates to an apparatus for performing the operations herein. This apparatus may be specially constructed for the required purposes, or it may comprise a general-purpose computer selectively activated or reconfigured by a computer program stored in the computer. Such a computer program may be stored in a computer readable storage medium, such as, but is not limited to, any type of disk including floppy disks, optical disks, CD-ROMs, and magnetic-optical disks, read-only memories (ROMs), random access memories (RAMs), EPROMs, EEPROMs, magnetic or optical cards, or any type of media suitable for storing electronic instructions, each coupled to a computer system bus.

The invention can take the form of an entirely hardware embodiment, an entirely software embodiment or an embodiment containing both hardware and software elements. In a preferred embodiment, the invention is implemented in software, which includes but is not limited to firmware, resident software, microcode, etc.

Furthermore, the invention can take the form of a computer program product accessible from a computer-usable or computer-readable medium providing program code for use by or in connection with a computer or any instruction execution system. For the purposes of this description, a computer-usable or computer readable medium can be any apparatus that can contain, store, communicate, propagate, or transport the program for use by or in connection with the instruction execution system, apparatus, or device.

The medium can be an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system (or apparatus or device) or a propagation medium. Examples of a computer-readable medium include a semiconductor or solid state memory, magnetic tape, a removable computer diskette, a random access memory (RAM), a read-only memory (ROM), a rigid magnetic disk and an optical disk. Current examples of optical disks include compact disk-read only memory (CD-ROM), compact disk-read/write (CD-R/W) and DVD.

A data processing system suitable for storing and/or executing program code will include at least one processor coupled directly or indirectly to memory elements through a system bus. The memory elements can include local memory employed during actual execution of the program code, bulk storage, and cache memories which provide temporary storage of at least some program code in order to reduce the number of times code must be retrieved from bulk storage during execution.

Input/output or I/O devices (including but not limited to keyboards, displays, pointing devices, etc.) can be coupled to the system either directly or through intervening I/O controllers.

Network adapters may also be coupled to the system to enable the data processing system to become coupled to other data processing systems or remote printers or storage devices through intervening private or public networks. Modems, cable modem and Ethernet cards are just a few of the currently available types of network adapters.

Finally, the algorithms and displays presented herein are not inherently related to any particular computer or other apparatus. Various general-purpose systems may be used with programs in accordance with the teachings herein, or it may prove convenient to construct more specialized apparatus to perform the required method steps. The required structure for a variety of these systems will appear from the description below. In addition, the present embodiment of invention is not described with reference to a particular programming language. It will be appreciated that a variety of programming languages may be used to implement the teachings of the invention as described herein.

FIG. 1 is a high level block diagram illustrating a system for securely authenticating an individual for accessing data or one or more applications. The system 100 comprises a Personal Digital Key (PDK) 102, a Reader 108, a network 110, a computing device 120, a local services module 124, a third party link module 126, a record system 128, a network 130 and a third party site 140. The Reader 108 is coupled to PDK 102 by a wireless link 106 and coupled to a network 110 by either a wired or wireless link represented by lines 152 and 154. The Reader 108 is also adapted to receive a biometric input 122 from a user and is capable of displaying status to a user. The PDK 102 is also adapted to receive biometric input 122 from a user. The network 110 couples the local services module 124 and third party link module 126 to the Reader 108. The network 110 also couples the local services module 124 and third party link module 126 to the record system 128 via signal lines 158 and 160. In alternative embodiments, different or additional external services, registries or databases (not shown) are coupled to the network 110. In another embodiment, the Reader 108 operates as a standalone device without a connection to the network 110. The network 130 couples the third party link module 126 to the third party site 140 and services provided by the third party site 140, such as pharmacy services, insurance services or lab services.

The system 100 addresses applications where it is important to ensure a specific individual is authorized to perform a given transaction. A transaction as used herein includes executing a purchase or financial dealing, enabling access to physical and/or digital items, providing identification or personal information or executing other tasks where it is important to authenticate an individual for use. In one embodiment, the Reader 108 wirelessly receives information stored in the PDK 102 that uniquely identifies the PDK 102 and the individual carrying the PDK 102. In another embodiment, the Reader 108 also receives a biometric input 122 from the individual. For example, the Reader 108 receives a fingerprint, a retinal scan, an iris scan, a facial scan or any other suitable biometric input associated with the individual. In one embodiment, the PDK 102 receives the biometric input 122 from the individual. Based on the received information, the Reader 108 determines if the transaction should be authorized. Beneficially, the system 100 provides comprehensive authentication without the need for PINs or passwords. Moreover, personal biometric

information need not be stored in any local or remote storage database and is only stored on the user's own PDK **102**. Furthermore, in one embodiment, purchase transactions can be efficiently completed without requiring the use of physical credit cards, tokens or other user action beyond initiating the transaction.

The PDK **102** is a compact, portable uniquely identifiable wireless device typically carried by an individual or affixed to an object or device. The PDK **102** stores digital information in a tamper-proof format uniquely associating the PDK **102** with an individual. Example embodiments of PDKs are described in more detail in U.S. patent application Ser. No. 11/292,330, entitled "Personal Digital Key And Receiver/Decoder Circuit System And Method" filed on Nov. 30, 2005; U.S. patent application Ser. No. 11/620,581 entitled "Wireless Network Synchronization Of Cells And Client Devices On A Network" filed on Jan. 5, 2007; and U.S. patent application Ser. No. 11/620,577 entitled "Dynamic Real-Time Tiered Client Access" filed on Jan. 5, 2007, the entire contents of which are all incorporated herein by reference.

To establish the trust, credibility and confidence of the authentication system, information stored in the PDK **102** is acquired by a process that is trusted, audited and easily verified. The process is ensured by a trusted third-party system, referred to herein as a "Notary," that administers the acquisition and storage of information in the PDK **102** according to defined security protocols. In one embodiment, the Notary is a system and/or a trusted individual that witnesses the acquisition and storage either in person or remotely. In another embodiment, the Notary comprises trusted hardware that administers the initialization process by an automated system. Thus, once initialized by the trusted process, the PDK **102** can prove that the information it stores is that of the individual. Example embodiments of the initialization process are described in U.S. patent application Ser. No. 11/744,832 to John Giobbi, et al., entitled "Personal Digital Key Initialization and Registration For Secure Transaction" filed on May 5, 2007, the entire contents of which are incorporated herein by reference.

The Reader **108** wirelessly communicates with the PDK **102** when the PDK **102** is within a proximity zone of the Reader **108**. The proximity zone can be, for example, several meters in radius and can be adjusted dynamically by the Reader **108**. Thus, in contrast to many conventional radio frequency identification (RFID) devices, the Reader **108** is able to detect and communicate with the PDK **102** without requiring an individual using, or associated with the PDK **102**, to remove the PDK **102** from his/her pocket, wallet, purse, etc. Generally, the Reader **108** receives uniquely identifying information from the PDK **102** and initiates an authentication process for the individual carrying the PDK **102**. In one embodiment, the Reader **108** is adapted to receive a biometric input **122** from the individual. The biometric input **122** comprises a representation of physical or behavioral characteristics unique to the individual. For example, the biometric input **122** can include a fingerprint, a palm print, a retinal scan, an iris scan, a photograph, a signature, a voice sample or any other biometric information such as DNA, RNA or their derivatives that can uniquely identify the individual. The Reader **108** compares the biometric input **122** to information received from the PDK **102** to determine if a transaction should be authorized. In one embodiment, the biometric input **122** can be obtained by a biometric reader **470** (FIG. 4) on the PDK **102** and transmitted to the Reader **108** for authentication. In another

embodiment, some or all of the authentication process can be performed by the PDK **102** instead of the Reader **108**.

The Reader **108** is further communicatively coupled to the network **110** in order to receive and/or transmit information to remote databases for remote authentication. In an alternative embodiment, the Reader **108** includes a non-volatile data storage that can be synchronized with one or more remote databases **112** or registries **114**, **116a**, **116b** (FIG. 2). Such an embodiment alleviates the need for a continuous connection to the network **110** and allows the Reader **108** to operate in a standalone mode and for the local data storage to be updated when a connection is available. For example, a standalone Reader **108** can periodically download updated registry entries and perform authentication locally without any remote lookup.

The network **110** provides communication between the Reader **108** and the computing device **120**, local services module **124**, and third party link module **126**. For example, a communication channel **156** couples the computing device **120** to the network **110**. For example, the communication channel **156** is a wired or wireless connection. In alternative embodiments, one or more of these connections may not be present or different or additional network connections may be present. In one embodiment, the network **110** uses standard communications technologies and/or protocols. Thus, the network **110** can include links using technologies such as Ethernet, 802.11, 802.16, integrated services digital network (ISDN), digital subscriber line (DSL), asynchronous transfer mode (ATM), etc. Similarly, the networking protocols used on the network **110** can include the transmission control protocol/Internet protocol (TCP/IP), the hypertext transport protocol (HTTP), the simple mail transfer protocol (SMTP), the file transfer protocol (FTP), etc. The data exchanged over the network **110** can be represented using technologies and/or formats including the hypertext markup language (HTML), the extensible markup language (XML), etc. In addition, all or some of links can be encrypted using conventional encryption technologies such as the secure sockets layer (SSL), Secure HTTP and/or virtual private networks (VPNs). In another embodiment, the entities can use custom and/or dedicated data communications technologies instead of, or in addition to, the ones described above.

Similarly, the network **130** provides communication between the local services module **124** and third party site **140**. In alternative embodiments, one or more of these connections may not be present or different or additional network connections may be present. In one embodiment, the network **130** uses standard communications technologies and/or protocols. Thus, the network **130** can include links using technologies such as Ethernet, 802.11, 802.16, integrated services digital network (ISDN), digital subscriber line (DSL), asynchronous transfer mode (ATM), etc. Similarly, the networking protocols used on the network **110** can include the transmission control protocol/Internet protocol (TCP/IP), the hypertext transport protocol (HTTP), the simple mail transfer protocol (SMTP), the file transfer protocol (FTP), etc. The data exchanged over the network **110** can be represented using technologies and/or formats including the hypertext markup language (HTML), the extensible markup language (XML), etc. In addition, all or some of links can be encrypted using conventional encryption technologies such as the secure sockets layer (SSL), Secure HTTP and/or virtual private networks (VPNs). In another embodiment, the entities can use custom and/or dedicated data communications technologies instead of, or in addition to, the ones described above.

FIG. 2 is a block diagram illustrating a local services module 124, which includes one or more external databases including a validation database 112, a Central Registry 114 and one or more private registries 116a, 116b. The local services module 124 also includes a medical services controller 202, a registration server 205, a tracking server 210, an auto login server 220, a portal server 230, an application server 240, an alert server 250 and a search server 260.

The validation database 112 stores additional information that may be used for authorizing a transaction to be processed at the Reader 108. For example, in purchase transactions, the validation database 112 is a credit card validation database that is separate from the merchant providing the sale. Alternatively, a different database may be used to validate different types of purchasing means such as a debit card, ATM card, or bank account number. As another example in healthcare systems, the validation database 112 is a medical record number validation database that separate from the healthcare institution providing the patient care, which provides confirmation of the patient's identification.

The registries 114, 116a, 116b are securely-accessible databases coupled to the network 110 that store, among other items, PDK, Notary, and Reader information. In one embodiment, the registries 114, 116a, 116b do not store biometric information. In an alternative embodiment, the registries 114, 116a, 116b store biometric information in an encoded format that can only be recovered using an algorithm or encoding key stored in the PDK 102. Information stored in the registries 114, 116a, 116b can be accessed by the Reader 108 via the network 110 for use in the authentication process. There are two basic types of registries 114, 116a, 116b illustrated: private registries 116a, 116b and the Central Registry 114. Private registries 116a, 116b are generally established and administered by their controlling entities (e.g., a health care provider, business authority, or other entity administering authentication). Private registries 116a, 116b can be custom configured to meet the specialized and independent needs of each controlling entity. The Central Registry 114 is a single highly-secured, centrally-located database administered by a trusted third-party organization. In one embodiment, all PDKs 102 are registered with the Central Registry 114 and may be optionally registered with one or more selected private registries 116a, 116b. In alternative embodiments, a different number or different types of registries 114, 116a, 116b may be coupled to the network 110.

In one embodiment, a registry 114, 116 or the database 112 includes one or more records. A record includes login information associated with one or more applications. For example, the record includes a PDK ID 312, an application identifier, an application username and an application password. When the PDK 102 is identified by a Reader, data from the registry profile is communicated to the local services module 124 and used to allow a user to login or access an application using the data stored in the registry profile. In one embodiment, different records in the registry 114, 116 or database 112 are encrypted using a registry key that is also stored in the PDK 102 to prevent access to a record without the PDK 102. One embodiment of launching, or accessing, an application using a registry profile is further described below in conjunction with FIGS. 18-20.

The medical services controller 202 enables communication between the servers and modules of the local services module 124 and third party link module 126 with the computing device 120. In one embodiment, the medical services controller 202 receives information and requests from the computing device 120 via the network 110. In

another embodiment, the medical services controller 202 coordinates the operation of the various servers and modules of the local services module 124 and third party link module 126. For example, when a patient registration request is received from the Reader 108, the medical services controller 202 routes the request to the registration server 205 and forwards registration confirmation to the appropriate destination, such as the computing device 120.

The registration server 205 automates the process of registering new patients and ensures that a patient never needs to register more than once. In one embodiment, the registration server 205 resides in the local services module 124, which is coupled to the network via signal line 158. In one embodiment, the registration server 205 is coupled to the validation database 112, central registry 114 and private registries 116a, 116b. The registration server 205 receives patient registration requests from Readers 108 via the network 110 and sends information to the computing device 120 also via the network 110.

The tracking server 210 enables real-time tracking of individuals, equipment and supplies. In one embodiment, the tracking server 210 resides in the local services module 124, which is coupled to the network 110 via signal line 158. The tracking server 210 receives information from the Readers 108 and sends information back to the Readers 108 and PDK 102. One embodiment of the tracking server 210 is described in more detail below with reference to FIG. 15.

The auto login server 220 allows for automated logging in of a user into a computer system. In one embodiment, the user is a healthcare provider logging into a healthcare computer system. In one embodiment, the auto login server 220 resides in the local services module 124 and is coupled to the validation database 112, central registry 114 and private registries 116a, 116b. The auto login server receives login requests from the Readers 108 and sends login authorization to the computing device 120. One embodiment of the auto login server 220 is described in more detail below with reference to FIG. 17.

The portal server 230 exchanges data between the local services module 124 and one or more third party sites 140. For example, the portal server 230 includes identifiers associated with one or more third party sites 140 to identify a third party site 140 and enable access to data maintained by the third party site 140. In one embodiment, the portal server 230 also modifies the format of data received from a third party site 140 to expedite use of the received data by another component, such as the application server 240 or a computing device 120 coupled to the local services module 124.

The application server 240 includes data that, when executed by a processor, implements one or more applications to provide one or more types of functionality. In one embodiment, the application server 240 is included in the local services module 124. Additionally, in one embodiment, the application server 240 communicates with one or more third party sites 140 via a signal line 164, which communicate with the third party link module 126, which connects to the network 130, which communicates with the third party site 140 via a communication channel 172. This allows the application server 240 to communicate data from the third party site 140 to the computing device 120. One embodiment of the application server 240 is described in more detail below with reference to FIG. 24. Such third party services may include accessing a patient's virtual database records or insurance information or sending prescription requests to

remote pharmacies. More detailed information describing the components and functions of these servers is described in more detail below.

The alert server **250** provides automatic updates and alerts for monitored patients or other entities. The alert server **250** receives information from Readers **108** and sends information to the computing device **120**. In one embodiment, the alert server **250** resides in the local services module **124**. In one embodiment, the alert server **250** receives data from the tracking server **210** to allow generation of updates or alerts based on the location of a PDK **102**. In one embodiment, the alert server **250** is configured to receive data from an alert editor. In one embodiment, the data received from the alert editor includes alert identifiers and objects associated with the alert identifiers

The search server **260** enables the user to search the tracking server **210** for one or more tracked items (e.g., users or assets) and request that the tracking server **210** generate or display one or more of a time and motion report, a tracked items location, historic locations and an alert. In an alternative embodiment, the search server **260** and or its functionality are part of the tracking server **210**.

Turning now to FIG. 3, an example embodiment of a PDK **102** is illustrated. The PDK **102** comprises a memory **310**, a programmer I/O **340**, control logic **350**, a transceiver **360**, a biometric reader **370** and a temp sensor **375** coupled by a bus **380**. The PDK **102** can be standalone as a portable, physical device or can be integrated into commonly carried items. For example, a PDK **102** can be integrated into a portable electronic device such as a cell phone, Personal Digital Assistant (PDA), or GPS unit, an employee identification tag or badge, clothing, or jewelry items such as watches, rings, necklaces or bracelets. In one embodiment, the PDK **102** can be, for example, about the size of a Subscriber Identity Module (SIM) card and be as small as a square inch in area or less. In another embodiment, the PDK **102** can be easily contained in a pocket, on a keychain, or in a wallet. In yet another embodiment, a PDK **102** can be integrated into a sticker, tag or other item attachable to various items or equipment. In other embodiments, the PDK **102** can be integrated into a clipboard, patient wristband or other patient identification tags or badges. In some embodiments, where the PDK **102** is attached to equipment for tracking purposes, the PDK **102** also includes a button or switch that can be activated or deactivated to indicate whether the equipment is in use.

The memory **310** can be a read-only memory, a once-programmable memory, a read/write memory or any combination of memory types including physical access secured and tamper-proof memories. The memory **310** typically stores a unique PDK ID **312**, an activity log **390** and one or more profiles **320**. The PDK ID **312** comprises a public section and a private section of information, each of which can be used for identification and authentication. In one embodiment, the PDK ID **312** is stored in a read-only format that cannot be changed subsequent to manufacture. The PDK ID **312** is used as an identifying feature of a PDK **102** and distinguishes between PDKs **102** in private **116** or Central **114** registry entries. In an alternative embodiment, the registries can identify a PDK **102** by a different ID than the PDK ID **412** stored in the PDK **102**, or may use both the PDK ID **312** and the different ID in conjunction. The PDK ID **312** can also be used in basic PDK authentication to ensure that the PDK **102** is a valid device.

The activity log **390** stores information associated with various activities of the PDK. For example, if the PDK **102** is a patient's PDK, the activity log **390** stores information

identifying the patient's location throughout various times. In one embodiment, the activity log **390** keeps track of each time a patient visits a healthcare facility or each time a doctor or nurse visits a department within the healthcare facility. In another embodiment, the activity log **390** stores the patient's location throughout various points as the patient is in the provider's facility. Similarly, if PDK **102** is attached to a piece of equipment or a cart of supplies, the activity log **390** stores location information as well. In another embodiment, if the PDK **102** is that of a provider, the activity log **390** stores information associated with the provider's rounds, i.e. each time a provider visits a certain patient or uses a particular medical device.

The profile fields **320** can be initially empty at the time of manufacture but can be written to by authorized individuals (e.g., a Notary) and/or hardware (e.g., a Programmer). In one embodiment, each profile **320** comprises a profile history **322** and profile data **330**. Many different types of profiles **320** are possible. A biometric profile, for example, includes profile data **330** representing physical and/or behavioral information that can uniquely identify the PDK owner. A PDK **102** can store multiple biometric profiles, each comprising a different type of biometric information. In one embodiment, the biometric profile **320** comprises biometric information transformed by a mathematical operation, algorithm, or hash that represents the complete biometric information (e.g., a complete fingerprint scan). In one embodiment, a mathematical hash is a "one-way" operation such that there is no practical way to re-compute or recover the complete biometric information from the biometric profile. This both reduces the amount of data to be stored and adds an additional layer of protection to the user's personal biometric information. In one embodiment, the biometric profile is further encoded using an encoding key and/or algorithm that is stored with the biometric profile data. Then, for authentication, the biometric profile data and the encoding key and/or algorithm are passed to the Reader **108**.

In one embodiment, the PDK **102** also stores one or more biometric profile "samples" associated with each biometric profile. The biometric profile sample is a subset of the complete profile that can be used for quick comparisons of biometric data. In one embodiment, the profile samples can be transmitted over a public communication channel or transmitted with reduced level of encryption while the full biometric profiles are only transmitted over secure channels. In the case of fingerprint authentication, for example, the biometric profile sample may represent only small portion area of the full fingerprint image. In another embodiment, the fingerprint profile sample is data that describes an arc of one or more lines of the fingerprint. In yet another embodiment, the fingerprint profile sample can be data representing color information of the fingerprint.

In another embodiment, the stored profiles **320** include a PIN profile that stores one or more PINs or passwords associated with the PDK owner. Here, the number or password stored in the PIN profile can be compared against an input provided by the user at the point of transaction to authenticate the user. In one embodiment, a PIN profile sample is also stored with the PIN profile that comprises a subset of the full PIN. For example, a PIN profile sample can be only the first two numbers of the PIN that can be used to quickly compare the stored PIN profile to a PIN obtained at the point of transaction.

In yet another embodiment, the PDK **102** stores a picture profile that includes one or more pictures of the PDK owner. In a picture profile authentication, the picture stored in the PDK **102** is transmitted to a display at the point of transac-

tion to allow an administrator (e.g., a clerk or security guard) to confirm or reject the identity of the individual requesting the transaction. In another embodiment, an image is captured of the individual at the point of transaction and compared to the picture profile by an automated image analysis means. Furthermore, picture profiles could be used, for example, in place of conventional passports or drivers licenses to authenticate the identity of an individual and allow for remote identification of individuals. For example, a police officer following a vehicle could obtain an image and identity of the driver while still maintaining a safe distance from the vehicle. In the hospitality industry, a host could greet a guest at the door of a hotel, casino or restaurant and easily recognize the guest by obtaining the guest's picture profile as he/she enters. In healthcare, a doctor or nurse can ensure that he or she is administering the correct medication to the right patient by looking at the profile picture associated with that patient.

A registry or database profile typically stores information associating the user with a registry. The registry profile can be used to determine if the individual is associated with the controlling entity for that registry and if different types of transactions are authorized for the individual. A registry profile can further include additional user information for use with the registry. For example, a private registry profile associated with a particular merchant may include a credit card number that the user has selected as a default for that merchant. In one embodiment, a profile can further include spending limits that limits the amount of purchases a user can make with a particular vendor or using a particular profile.

A registry profile may include one or more service blocks identifying a registry **114**, **116** or database **112** in the local services module **124** and identify a record within the identified registry **114**, **116** or database **112**. In one embodiment, the service block includes a registry identifier, a record identifier to specify a record within the identified registry and a registry key. In one embodiment, different records in the registry **114**, **116** or database **112** are encrypted using registry key that is stored in the PDK **102** to prevent access to a record without the PDK **102**. In one embodiment, one or more processes implemented by the control logic **350** are used to identify a service block within a registry profile, allowing access to specific service blocks. This also allows application of service block-specific security by making different service blocks independent of each other. One embodiment of launching, or accessing, an application using a registry profile is further described below in conjunction with FIGS. **18-21**.

Additionally, a profile may include application specific information, allowing a registry profile to be used to launch or access an application and application specific information included in the registry profile or in another profile to be accessed by the application. This allows the PDK **102** to include data customizing operation of an application. For example, a patient of a healthcare facility may have a PDK **102** having a profile that stores the patient's medical records, allowing a computing device **120** to retrieve the patient's medical records when the PDK **102** communicates with a Reader **108** coupled to the computing device **120**. As another example, a PDK **102** profile includes user preference data, allowing configuration of an application executed by a computing device **120** by communicating the user preference data from the PDK **102** to the computing device **120** via a Reader **108** coupled to the computing device **120**. Hence, in addition to including data used for authentication or

security, a PDK **102** may include profiles for customizing operation of applications or for storing data for subsequent access.

A profile can further include personal identification information such as name, address, phone number, etc., insurance information, credit/debit card information, or information regarding visited providers. This information can be useful for certain types of transactions. For example, patient office visits, a PDK **102** can automatically transmit address, insurance and billing information to the Reader **108** at the conclusion of the office visit.

Generally, some types of profile information (e.g., a biometric profile) can only be acquired during a trusted initialization process that is administered by a trusted Notary. In one embodiment, other secure information such as medical conditions are also stored to the PDK **102** in the presence of a Notary. Alternatively, certain types of low-risk information can be added by the user without a Notary, such as, for example a change of address. In another embodiment, once an initial profile has been stored to the PDK **102**, a user can add information to the PDK **102** using a Programmer without a Notary through self-authentication. For example, in one embodiment, a PDK **102** that has a stored biometric profile can be "unlocked" by providing a matching biometric input. Then, once unlocked, the user can add or remove additional profiles, insurance cards, personal information, etc. to the PDK **102** using a Programmer. For example, in one embodiment, a user that has unlocked his/her own PDK **102** can store additional biometric information (such as fingerprint information for other fingers) in his/her PDK **102**. In another example, a user that cancels an insurance card, can unlock his/her PDK **102** to remove the insurance card information. In another embodiment, the user can make copies of the PDK **102** or move profiles from one PDK **102** to another once the PDK **102** is unlocked. FIG. **25** provides additional description of acquisition of an initialization process.

The profile history **322** includes a programmer ID field **324**, a Notary ID **326**, and a site ID field **328**. The profile history **322** relates to the specific hardware, Notary, and site used at the time the profile data was created and stored to the PDK. Typically each profile **320** stores its specific profile history **322** along with the profile data **330**. The profile history **322** can be recalled for auditing purposes at a later time to ensure the credibility of the stored data. In one embodiment, transaction history can also be stored to the PDK memory **310**. Here, the PDK **102** stores information associated with any transactions made with the PDK **102** such as the healthcare provider, reason for office visit and insurance used, etc.

The PDK **102** also includes a programmer I/O **340** that provides an interface to a trusted Programmer (not shown). The Programmer comprises trusted hardware that is used to program the memory **310** of the PDK **102**. An example embodiment of a Programmer is described in U.S. patent application Ser. No. 11/744,832 to John Giobbi, et al., entitled "Personal Digital Key Initialization and Registration For Secure Transaction" and filed on May 5, 2007, the entire contents of which are incorporated herein by reference. The programmer I/O **340** can be, for example, a USB interface, serial interface, parallel interface, or any other direct or wireless link for transferring information between the PDK **102** and the Programmer. When coupled to the Programmer, the programmer I/O **340** receives initialization data, registration data or other information to be stored in the memory **310**. In one embodiment, the programmer I/O **340** is attached to an asset (e.g., equipment) in order to monitor the

asset and trigger alerts. For example, in one embodiment, the programmer I/O may be connected to a piece of equipment, detect a low battery and generate an alert. In one embodiment, if the battery is low or the equipment is due for service or re-calibration programmer I/O may send an output to the equipment to turn on an LED, for example, to make the equipment easier to identify in a crowded supply closet.

The control logic 350 coordinates between functions of the PDK 102. In one embodiment, the control logic 350 facilitates the flow of information between the programmer I/O 340, transceiver 360 and memory 310. The control logic 350 can further process data received from the memories 310, programmer I/O 340 and transceiver 360. Note that the control logic 350 is merely a grouping of control functions in a central architecture, and in other embodiments, the control functions can be distributed between the different modules of the PDK 102. The operation of the control logic will be understood to those skilled in the art based on the description below corresponding to FIGS. 8-11D.

Optionally, the PDK 102 can also include a built in biometric reader 370 to acquire a biometric input from the user. The biometric reader 370 is configured to obtain a representation of physical or behavioral characteristics derived from the individual. The biometric input can be used to unlock the PDK 102 for profile updates, or for various types of authentication. For example, in one embodiment, a biometric input is received by the PDK 102 and compared to stored biometric information. Then, if the user is authenticated, the PDK 102 can indicate to the Reader 108 that the user is authenticated and transmit additional information (e.g., a credit card number) needed to complete a transaction.

Optionally, the PDK 102 can also include a temp sensor 375 to acquire temperature readings, which may be used in tracking and reporting an asset's temperature or generating a temperature alert as described further below. The temp sensor 375 can be communicatively coupled to the PDK 102 or integrated into the PDK as illustrated depending upon the embodiment. In another embodiment, the temp sensor 375 is separate from the PDK and communicatively coupled to the PDK through the PDK's I/O port or is communicatively coupled to a Reader 108.

The transceiver 360 is a wireless transmitter and receiver for wirelessly communicating with a Reader 108 or other wireless device. The transceiver 360 sends and receives data as modulated electromagnetic signals. Moreover, the data can be encrypted by the transceiver 360 and transmitted over a secure link. Further, the transceiver 360 can actively send connection requests, or can passively detect connection requests from another wireless source. In one embodiment, the transceiver 360 is used in place of a separate programmer I/O 340 and is used to wirelessly communicate with the Programmer for programming. In one embodiment, the transceiver 360 is adapted to communicate over a range of up to around 5 meters.

FIG. 4 is a block diagram illustrating one embodiment of a biometric reader 370 of a PDK 102. The biometric reader 370 includes a biometric capture module 402, a validation module 404, an enrollment module 406 and persistent storage 408. In one embodiment, the enrollment module 406 registers a user with a PDK 102 by persistently storing biometric data associated with the user. Further, enrollment module 406 registers PDK 102 with a trusted authority by providing the code (e.g., device ID or PDK ID 312) to the trusted authority. Or conversely, the trusted authority can provide the code to PDK 102 to be stored therein.

The biometric capture module 402 comprises a scan pad to capture scan data from a user's fingerprint (e.g., a digital or analog representation of the fingerprint). Other embodiments of the biometric capture module 402 includes retinal scanners, iris scanners, facial scanner, palm scanners, DNA/RNA analyzers, signature analyzers, cameras, microphones, and voice analyzers to capture other identifying biometric data. Using the biometric data, validation module 404 determines whether the user's fingerprint, or other biometric data, matches the stored biometric data from enrollment. Conventional techniques for comparing fingerprints can be used. For example, the unique pattern of ridges and valleys of the fingerprints can be compared. A statistical model can be used to determine comparison results. Validation module 404 can send comparison results to control logic 350 of the PDK 102.

In other embodiments, validation module 404 can be configured to capture biometric data for other human characteristics. For example, a digital image of a retina, iris, and/or handwriting sample can be captured. In another example, a microphone can capture a voice sample.

Persistent storage 408 persistently stores biometric data from one or more users which can be provided according to specific implementations. In one embodiment, at least some of persistent storage 408 is a memory element that can be written to once but cannot subsequently be altered. Persistent storage 408 can include, for example, a ROM element, a flash memory element, or any other type of non-volatile storage element. Persistent storage 508 is itself, and stores data in, a tamper-proof format to prevent any changes to the stored data. Tamper-proofing increases reliability of authentication because it does not allow any changes to biometric data (i.e., allows reads of stored data, but not writes to store new data or modify existing data). Furthermore, data can be stored in an encrypted form.

In one embodiment, persistent storage 408 also stores the code that is provided by the PDK 102 responsive to successful verification of the user. Further, in some embodiments persistent storage 408 stores other data utilized during the operation of PDK 102. For example, persistent storage 408 can store encryption/decryption keys utilized to establish secure communications links.

An example embodiment of PDK 102 including a biometric reader is described in U.S. patent application Ser. No. 11/314,199 to John Giobbi, et al., entitled "Biometric Personal Data Key (PDK) Authentication", the entire contents of which are incorporated herein by reference.

Turning now to FIG. 5, an example embodiment of a Reader 108 is illustrated. The embodiment includes one or more biometric readers 502, a receiver-decoder circuit (RDC) 504, a processor 506, a network interface 508, an I/O port 612, optionally a credit card terminal I/O 510 and a reader ID 518. In alternative embodiments, different or additional modules can be included in the Reader 108.

The RDC 504 provides the wireless interface to the PDK 102. Generally, the RDC 504 wirelessly receives data from the PDKs 102 in an encrypted format and decodes the encrypted data for processing by the processor 506. An example embodiment of an RDC is described in U.S. patent application Ser. No. 11/292,330 entitled "Personal Digital Key And Receiver/Decoder Circuit System And Method", the entire contents of which are incorporated herein by reference. Encrypting data transmitted between the PDK 102 and Reader 108 minimizes the possibility of eavesdropping or other fraudulent activity. In one embodiment, the RDC 504 is also configured to transmit and receive certain types of information in an unencrypted or public format.

The biometric reader **502** receives and processes the biometric input **122** from an individual and is configured to obtain a representation of physical or behavioral characteristics derived from the individual. In one embodiment, the biometric reader **602** is a fingerprint scanner. Here, the biometric reader **502** includes an image capture device adapted to capture the unique pattern of ridges and valleys in a fingerprint also known as minutiae. Other embodiments of biometric readers **502** include retinal scanners, iris scanners, facial scanner, palm scanners, DNA/RNA analyzers, signature analyzers, cameras, microphones, and voice analyzers. Furthermore, the Reader **108** can include multiple biometric readers **502** of different types. In one embodiment, the biometric reader **502** automatically computes mathematical representations or hashes of the scanned data that can be compared to the mathematically processed biometric profile information stored in the PDK **102**.

The processor **506** can be any general-purpose processor for implementing a number of processing tasks. Generally, the processor **506** processes data received by the Reader **108** or data to be transmitted by the Reader **108**. For example, a biometric input **122** received by the biometric reader **502** can be processed and compared to the biometric profile **320** received from the PDK **102** in order to determine if a transaction should be authorized. In different embodiments, processing tasks can be performed within each individual module or can be distributed between local processors and a central processor. The processor **506** further includes a working memory for use in various processes.

The network interface **508** is a wired or wireless communication link between the Reader **108** and one or more external databases such as, for example, a validation database **112**, the Central Registry **114** or a private registry **116a**, **116b**. For example, in one type of authentication, information is received from the PDK **102** at the RDC **504**, processed by the processor **506**, and transmitted to an external database **112-116** through the network interface **508**. The network interface **508** can also receive data sent through the network **110** for local processing by the Reader **108**. In one embodiment, the network interface **508** provides a connection to a remote system administrator to configure the Reader **108** according to various control settings.

The I/O port **512** provides a general input and output interface to the Reader **108**. The I/O port **512** may be coupled to any variety of input devices to receive inputs such as a numerical or alphabetic input from a keypad, control settings, menu selections, confirmations, and so on. Outputs can include, for example, status LEDs, an LCD, or other display that provides instructions, menus or control options to a user.

The credit card terminal I/O **510** optionally provides an interface to an existing credit card terminal **514**. In embodiments including the credit card terminal I/O **510**, the Reader **108** supplements existing hardware and acts in conjunction with a conventional credit card terminal **514**. In an alternative embodiment, the functions of an external credit card terminal **514** are instead built into the Reader **108**. Here, a Reader **108** can completely replace an existing credit card terminal **514**.

In one embodiment, a Reader **108** is adapted to detect and prevent fraudulent use of PDKs that are lost, stolen, revoked, expired or otherwise invalid. For example, the Reader **108** can download lists of invalid PDKs IDs **312** from a remote database and block these PDKs **102** from use with the Reader **108**. Furthermore, in one embodiment, the Reader **108** can update the blocked list and/or send updates to remote registries **114**, **116a**, **116b** or remote Readers **108**

upon detecting a fraudulently used PDK **102**. For example, if a biometric input **122** is received by the Reader **108** that does not match the biometric profile received from the PDK **102**, the Reader **108** can obtain the PDK ID **312** and add it to a list of blocked PDK IDs **312**. In another embodiment, upon detecting fraudulent use, the Reader **108** can send a signal to the PDK **102** that instructs the PDK **102** to deactivate itself. The deactivation period can be, for example, a fixed period of time, or until the rightful owner requests re-activation of the PDK **102**. In yet another embodiment, the Reader **108** can send a signal instructing the fraudulently obtained PDK **102** to send alarm signals indicating that the PDK **102** is a stolen device. Here, a stolen PDK **102** can be tracked, located and recovered by monitoring the alarm signals. In one embodiment, the Reader **108** stores biometric or other identifying information from an individual that attempts to fraudulently use a PDK **102** so that the individual's identity can be determined.

The reader ID **518** is memory that stores the reader's unique identification number. The memory can be a read-only memory, a once-programmable memory, a read/write memory or any combination of memory types including physical access secured and tamper-proof memories. The reader ID **518** plays an integral role in the process for tracking equipment, supplies and individuals as will be explained in more detail below.

Generally, the Reader **108** is configured to implement at least one type of authentication prior to enabling a transaction. In many cases, multiple layers of authentication are used. A first layer of authentication, referred to herein as "device authentication," begins any time a PDK **102** moves within range of a Reader **108**. In device authentication, the Reader **108** and the PDK **102** each ensure that the other is valid based on the device characteristics, independent of any profiles stored in the PDK **102**. In some configurations, when fast and simple authentication is desirable, only device authentication is required to initiate the transaction. For example, a Reader **108** may be configured to use only device authentication for office visit check-ins. The configuration is also useful in other types of low risk transactions where speed is preferred over additional layers of authentication.

Other configurations of the Reader **108** require one or more additional layers of authentication, referred to herein as "profile authentication" based on one or more profiles stored in the PDK **102**. Profile authentication can include, for example, a biometric authentication, a PIN authentication, a photo authentication, a registry authentication, etc. or any combination of the above authentication types. Profile authentications are useful when a more exhaustive authentication process is desired, for example, for invasive patient treatments or drug administration.

FIG. 6 is a high-level block diagram of one embodiment of a computing device **120**. In one embodiment, the computing device **120** is a personal computer. In another embodiment, the computing device **120** is a smart phone or other mobile computing and communication device. Illustrated are at least one processor **602** coupled to a bus **604**. Also coupled to the bus **604** are a memory **606**, a storage device **608**, a keyboard **610**, a graphics adapter **612**, a pointing device **614**, a network adapter **616** and a reader **620**. In one embodiment, the functionality of the bus **604** is provided by an interconnecting chipset. A display device **618** is coupled to the graphics adapter **612**.

The memory **606** includes an application **630**. In one embodiment, the application **630** enables the computing device **120** to communicate with the local services **124**. In another embodiment, the application **630** processes infor-

mation and data received from the readers **620** and various modules and servers of the local services **124** and third party link module **126**.

The storage device **608** is any device capable of holding data, like a hard drive, compact disk read-only memory (CD-ROM), DVD, or a solid-state memory device. The memory **606** holds instructions and data used by the processor **602**. The pointing device **614** may be a mouse, track ball, or other type of pointing device, and is used in combination with the keyboard **610** to input data into the computing device **120**. The graphics adapter **612** displays images and other information on the display device **618**. The network adapter **616** couples the computing device **120** to a local or wide area network.

As is known in the art, a computing device **120** can have different and/or other components than those shown in FIG. **6**. In addition, the computing device **120** can lack certain illustrated components. In one embodiment, a computing device **120** lacks a keyboard **610**, a pointing device **614**, a graphics adapter **612**, and/or a display device **618**. Moreover, the storage device **608** can be local and/or remote from computing device **120** (such as embodied within a storage area network (SAN)). The reader **620** includes all or some of the components as the Reader **108** described above in conjunction with FIG. **5**.

As is known in the art, the computing device **120** is adapted to execute computer program modules for providing functionality described herein. As used herein, the term “module” refers to computer program logic utilized to provide the specified functionality. Thus, a module can be implemented in hardware, firmware, and/or software. In one embodiment, program modules are stored on the storage device **608**, loaded into the memory **606**, and executed by the processor **602**.

Embodiments of the entities described herein can include other and/or different modules than the ones described here. In addition, the functionality attributed to the modules can be performed by other or different modules in other embodiments. Moreover, this description occasionally omits the term “module” for purposes of clarity and convenience.

FIG. **7** is a flowchart illustrating one embodiment of a process for authorizing a communication connection using secure authentication. When a PDK **102** comes within range of a Reader **108**, communication is automatically established between the RDC **504** of the Reader **108** and the PDK **102**. It should be noted that the processes described herein with regards to Reader **108** may be also performed with reader **620** of the computing device **120**.

In one embodiment, the RDC **504** continually transmits beacons that are detected by the PDK **102** when it enters a proximity zone of the Reader **108**. In an alternative embodiment, the communication is instead initiated by the PDK **102** and acknowledged by the Reader **108**. The initial communication between the Reader **108** and the PDK **102** may or may not be encrypted to provide increased security of communication between the Reader and the PDK **102**.

In step **704**, a device authentication is performed. Here, the Reader **108** establishes if the PDK **102** is a valid device and PDK **102** establishes if the Reader **108** is valid. Furthermore, device authentication determines if the PDK **102** is capable of providing the type of authentication required by the Reader **108**.

An example embodiment of a method **800** for performing **704** device authentication is illustrated in FIG. **8**. The RDC **504** receives and analyzes **802** information from the PDK **102** and the PDK **102** receives and analyzes **802** information received from the RDC **504**. Generally, this initial informa-

tion is transmitted over a public communication channel in an unencrypted format. Based on the received information, each device **102**, **504** determines **804** if the other is valid. As will be apparent to one of ordinary skill in the art, a number of different protocols can be used for this type of authentication such as, for example, a challenge-response authentication or a challenge handshake authentication protocol (CHAP). If either of the devices **102**, **504** is invalid **812**, the process ends. If both the PDK **102** and the RDC **604** are determined by the other to be valid, the Reader **108** requests and receives **806** authentication type information from the PDK **102** indicating the different types of authentication the PDK **102** is capable of satisfying based on the types of profiles stored by the PDK **102**.

The available profile types in the PDK **102** are compared against the authentication types that can be used by the Reader **108**. For example, a particular Reader **108** may be configured to perform only a fingerprint authentication and therefore any PDK without a fingerprint biometric profile cannot be used with the Reader **108**. In one embodiment, the Reader **108** can allow more than one type of profile to be used. In another embodiment, the Reader **108** requires more than one type of profile for authentication, while in yet further embodiments no profile authentications are required. Next, the method determines **808** whether the PDK **102** has one or more profiles sufficient for authentication. If the PDK **102** does not have one or more profiles sufficient for authentication with the Reader **108**, the devices **102**, **504** are determined to be invalid **812** because they cannot be used with each other. If the PDK **102** does have one or more sufficient types of profiles, the devices are valid **810**.

Turning back to FIG. **7**, if either the PDK **102** or RDC **504** is not found valid (**706-No**) during device authentication **704**, the connection is not authorized **718** and the process ends. If the devices are valid (**706—Yes**), the RDC **504** temporarily buffers **708** the received PDK information. It is noted that in one embodiment, steps **702-708** are automatically initiated each time a PDK **102** enters the proximity zone of the Reader **108**. Thus, if multiple PDKs **102** enter the proximity zone, the Reader **108** automatically determines which PDKs **102** are valid and buffers the received information from each valid PDK **102**.

The method next determines **710** whether profile authentication is required based on the configuration of the Reader **108**, the type of transaction desired or by request of a merchant or other administrator. If the Reader **108** configuration does not require a profile authentication in addition to the PDK authentication, then the Reader **108** proceeds to complete the transaction for the PDK **102**. If the Reader **108** does require profile authentication, the profile authentication is performed **712** as will be described below with references to FIGS. **9-10D**. If a required profile is determined **714** to be valid, the Reader **108** allows **716** the connection. Otherwise, the Reader **108** indicates that the connection is not authorized **718**. In one embodiment, allowing **716** the connection includes enabling access to secure patient records. In another embodiment, allowing **716** the connection includes enabling the automatic logging in and out of software and system applications. Patient or provider name or medical record number (typically stored in a profile memory field **332**) can be transmitted by the PDK **102** for identification purposes. In one embodiment, the PDK **102** is configured with multiple purchasing means and a default is configured for different types of transactions. In another embodiment, each insurance card or medical billing information is displayed to the customer by the Reader **108** and the customer is allowed to select which to apply to the office visit.

21

Turning now to FIG. 9, an embodiment of a method 900 for profile authentication is illustrated. In step 902, a secure communication channel is established between the RDC 504 and the PDK 102. Information sent and received over the secure channel is in an encrypted format that cannot be practically decoded, retransmitted, reused, or replayed to achieve valid responses by an eavesdropping device. The Reader 108 transmits 904 profile authentication requests to the PDK 102 requesting transmission of one or more stored profiles over the secure channel.

In one embodiment, a trigger is required certain times, but not required within specified time intervals. This allows a trigger to initially be required to authenticate a profile, but not required after initial authentication of the profile. For example, a trigger may be required to authenticate a profile the first time the Reader 108 transmits 904 a profile authentication request to the PDK 102, prompting a biometric authentication, or other type of authentication, as further described below. If the profile is authenticated, the next time the Reader 108 transmits 904 a profile authentication request to the PDK 102 during a specified time interval, no trigger is required and the Reader 108 relies on the previous authentication to authenticate the profile. Thus, the time interval simplifies access to a computing device 120 associated with the Reader 108 by identifying a length of time during which the profile is considered to be authenticated without being tested or without requiring detection of a trigger, as described below.

For example, the first time a healthcare provider accesses a computing device 120, the healthcare provider is required to provide a biometric input, as further described below, to verify the identity of the healthcare provider. To simplify subsequent access to the computing device 120, a time interval of four hours is associated with the healthcare provider's profile, so that the healthcare provider's profile remains authenticated by the Reader 108 for four hours after initial authentication. This allows the healthcare provider to subsequently access the computing device 120 without again providing biometric input. However, after four hours have elapsed, when the healthcare provider again accesses the Reader 108, the Reader 108 again requires the healthcare provider to provide a biometric input to verify the healthcare provider's profile.

Accordingly, after the Reader 108 transmits 904 profile authentication requests to the PDK 102 requesting transmission of one or more stored profiles over the secure channel and received a stored profile for authentication, the Reader 108 determines 906 whether a requested profile is within an associated time interval. In one embodiment, the time interval data is transmitted by the PDK 102 along with the profile. Alternatively, the Reader 108 includes data describing time interval data associated with different profiles and uses the included data to determine 906 whether the profile is within its associated time interval. For example, the time interval data includes a profile ID, the time interval and the time when the profile was last authenticated. The Reader 108 determines whether the time when the profile is received responsive to an authentication request is within the duration specified by the time interval of the time when the profile was last authenticated.

If the profile is not within its associated time interval (906-No), the process determines 908 whether a "trigger" is required for authentication. The requirement for a trigger depends on the configuration of the Reader 108, the specific type of transaction to be executed and the type of authentication requested. For example, if it has been longer than the time interval from the time when the profile was previously

22

authenticated to the time when the profile is received responsive to the authentication request, the process determines 908 whether a trigger is needed to authenticate the profile.

In a first configuration, a trigger is required to continue the process because of the type of authentication being used. For example, in biometric authentication, the authentication process cannot continue until the Reader 108 detects a biometric contact and receives biometric information. It is noted that biometric contact is not limited to physical contact and can be, for example, the touch of a finger to a fingerprint scanner, the positioning of a face in front of a facial or retinal scanner, the receipt of a signature, the detection of a voice, the receipt of a DNA sample, RNA sample, or derivatives or any other action that permits the Reader 108 to begin acquiring the biometric input 122. By supplying the biometric contact, the user indicates that the authentication and transaction process should proceed. For example, a PDK holder that wants log in to the healthcare software application system via the computing device 120 initiates the login process by touching a finger to the reader 720 of the computing device 120. The computing device 120 then displays confirmation of the user's login.

In a second configuration, some other user action is required as a trigger to proceed with the transaction even if the authentication process itself does not necessarily require any input. This can be used for many purchasing transactions to ensure that the purchase is not executed until intent to purchase is clear. For example, a Reader 108 at a gas station can be configured to trigger the transaction when a customer begins dispensing gas. At a supermarket, a Reader 108 can be configured to trigger the transaction when items are scanned at a checkout counter. Similarly, a user may login to a healthcare software application system via the computing device 120 by simply being in the proximity zone of the reader 620 of a computing device 120 and beginning to use the keyboard 610 or pointing device 614 of the computing device 120.

In a third configuration, no trigger is used and the Reader 108 automatically completes the remaining authentication/transaction with no explicit action by the user. This configuration is appropriate in situations where the mere presence of a PDK 102 within range of the Reader 108 is by itself a clear indication of the person associated with the PDK 102 desires to complete a transaction. For example, a Reader 108 can be positioned inside the entrance to a doctor's office or clinic. When a patient having an associated PDK 102 walks through the entrance, the Reader 108 detects the PDK 102 within range, authenticates the user, and notifies the receptionist that the patient has arrived for his or her appointment. Thus, if no trigger is required, the process next performs 914 the requested profile authentication tests.

If a trigger is required, the Reader 108 monitors 910 its inputs (e.g., a biometric reader, key pad, etc.) and checks for the detection 912 of a trigger. If the required trigger is detected, the process continues to perform 914 one or more profile authentication test. FIGS. 10A-10D illustrate various embodiments of profile authentication tests. According to different configurations of the Reader 108, one or more of the illustrated authentication processes may be used. Further, in some embodiments, one or more of the processes may be repeated (e.g., for different types of biometric inputs).

However, if the Reader 108 determines 906 that the requested profile is received within an associated time interval, the Reader authenticates 916 the profile. This beneficially simplifies access to a computing device 120 coupled to the Reader 108 by allowing an individual to

bypass profile authentication when the Reader 108 is accessed within a time interval of the initial profile authentication.

FIG. 10A illustrates a method 1000A for biometric authentication. In biometric authentication, a Reader 108 compares a biometric profile stored in the PDK 102 to the biometric input 122 acquired by the biometric reader 502. Advantageously, the biometric input 122 is not persistently stored by the Reader 108, reducing the risk of theft or fraudulent use. If the Reader 108 determines 1002 that biometric authentication is requested, the Reader 108 scans 1104 the biometric input 122 supplied by the user. In one embodiment, scanning 1004 includes computing a mathematical representation or hash of the biometric input 122 that can be directly compared to the biometric profile.

In one embodiment, scanning 1004 also includes obtaining a biometric input sample from the biometric input according to the same function used to compute the biometric profile sample stored in the PDK 102. Optionally, the Reader 108 receives 1008 a biometric profile sample from the PDK 102 and determines 1010 if the biometric profile sample matches the biometric input sample. If the biometric profile sample does not match the input sample computed from the scan, the profile is determined to be invalid 1018. If the biometric profile sample matches, the full biometric profile 1012 is received from the PDK 102 to determine 1014 if the full biometric profile 1012 matches the complete biometric input 122. If the profile 1012 matches the scan, the profile 1012 is determined to be valid 1120, otherwise the profile 1012 is invalid 1018. It is noted that in one embodiment, steps 1008 and 1010 are skipped and only a full comparison is performed. In one embodiment, the biometric profile and/or biometric profile sample is encoded and transmitted to the Reader 108 along with an encoding key and/or algorithm. Then, the Reader 108 uses the encoding key and/or algorithm to recover the biometric profile and/or biometric profile sample. In another alternative embodiment, only the encoding key and/or algorithm is transmitted by the PDK 102 and the biometric profile data is recovered from a remote database in an encoded form that can then be decoded using the key and/or algorithm.

It will be apparent to one of ordinary skill that in alternative embodiments, some of the steps in the biometric profile authentication process can be performed by the PDK 102 instead of the Reader 108 or by an external system coupled to the Reader 108. For example, in one embodiment, the biometric input 122 can be scanned 1004 using a biometric reader built into the PDK 102. Furthermore, in one embodiment, the steps of computing the mathematical representation or hash of the biometric input and/or the steps of comparing the biometric input to the biometric profile can be performed by the PDK 102, by the Reader 108, by an external system coupled to the Reader 108, or by any combination of the devices. In one embodiment, at least some of the information is transmitted back and forth between the PDK 102 and the Reader 108 throughout the authentication process. For example, the biometric input 122 can be acquired by the PDK 102, and transmitted to the Reader 108, altered by the Reader 108, and sent back to the PDK 102 for comparison. Other variations of information exchange and processing are possible without departing from the scope of the invention. The transfer of data between the PDK 102 and the Reader 108 and/or sharing of processing can provide can further contribute to ensuring the legitimacy of each device.

FIG. 10B illustrates a method 1000B for PIN authentication. If PIN authentication is requested 1024, a PIN is

acquired 1026 from the user through a keypad, mouse, touch screen or other input mechanism. Optionally, the Reader 108 receives 1028 a PIN sample from the PDK 102 comprising a subset of data from the full PIN. For example, the PIN sample can comprise the first and last digits of the PIN. If the Reader 108 determines 1030 that the PIN sample does not match the input, the profile is immediately determined to be invalid 1036. If the PIN sample matches, the full PIN profile is received 1032 from the PDK 102 and compared to the input. If the Reader 108 determines 1034 that the profile matches the input, the profile is determined to be valid and is otherwise invalid 1036. It is noted that in one embodiment, steps 1028 and 1030 are skipped.

FIG. 10C illustrates a method 1000C for a picture authentication. If the Reader 108 determines 1042 that picture authentication is requested, a picture profile is received 1044 from the PDK 102 by the Reader 108 and displayed 1046 on a screen. An administrator (e.g., a clerk, security guard, etc.) is prompted 1048 to compare the displayed picture to the individual and confirms or denies if the identities match. If the administrator confirms that the identities match, the picture profile is determined to be valid 1054 and is otherwise invalid 1052. In an alternative embodiment, the process is automated and the administrator input is replaced with a process similar to that described above with reference to FIG. 10A. Here, an image of the user is captured and face recognition is performed by comparing picture profile information received from the PDK 102 to the captured image.

FIG. 10D illustrates a method 1000D for authentication with a private registry 116a, 116b or the Central Registry 114. If the Reader 108 determines that registry authentication is requested, a secure communication channel is established 1062 over the network 110 between the Reader 108 and one or more registries (e.g., the Central Registry 114, any private registry 116a, 116b, or other validation database 112). If any additional information is needed to process the registry authentication (e.g., an insurance policy number), the Reader 108 requests and receives the additional information from the PDK 102. Identification information is transmitted 1064 from the Reader 108 to the registry 114, 116a, 116b through the network interface 608. The PDK status is received 1066 from the registry to determine 1068 if the status is valid 1072 or invalid 1070. In one embodiment, the information is processed remotely at the registry 114, 116a, 116b and the registry 114, 116a, 116b returns a validation decision to the Reader 108. In another embodiment, the Reader 108 queries the private 116a, 116b or Central registry 114 for information that is returned to the Reader 108. The information is then analyzed by the Reader 108 and the authorization decision is made locally. In one embodiment, the process involves transmitting credit card (or other purchasing information) to a validation database 112 to authorize the purchase and receive the status of the card. Status information may include, for example, confirmation that the card is active and not reported lost or stolen and that sufficient funds are present to execute the purchase.

FIGS. 11A and 11B illustrate scenarios where multiple PDKs 102a-e are present near a Reader 108. This scenario is common when a Reader 108 is located in a high occupancy area such as, for example, a hospital lobby or waiting area. In FIG. 11A, the Reader 108 communicates with PDKs 102a-d within the proximity zone 1102 and does not communicate with PDKs 102e-f outside the proximity zone 1102. In one embodiment, the Reader 108 receives the unique PDK ID from a PDK 102 when it enters the proximity zone 1102 and records its time of arrival. In one embodiment, the Reader 108 further initiates a device

authentication of the PDK 102 after a predefined period of time (e.g., 5 seconds) that the PDK 102 is within the proximity zone 1102. For profile authentication, the Reader 108 automatically determines which PDK 102 should be associated with an authentication test and the transaction. For example, if the Reader 108 receives a biometric input 122 from an individual, the Reader 108 automatically determines which PDK 102a-d is associated with the individual supplying the biometric input 122. In another embodiment, a different trigger is detected (e.g., a PIN input) to initiate the differentiation decision. In yet another embodiment, the differentiation decision is initiated without any trigger. It is noted that in some embodiments, where no trigger is required (such as a registry authentication), no differentiation decision is made and authentications are instead performed for each PDK 102 within the proximity zone 1102.

In one embodiment, the proximity zone 1102 is scalable, allowing modification of the area in which the Reader 108 communicates with a PDK 102. For example, the proximity zone 1102 of a Reader 108 may be modified from 1 foot to 100 feet. In one embodiment, an administrator or other designated individual modifies the proximity zone 1102 of a Reader 108. This allows the sensitivity of a Reader 108 to be modified based on different operating environment. For example, in a healthcare provider setting, the proximity zone 1102 of a Reader 108 located in a doctor's office is smaller than the proximity zone 1102 of a Reader 108 located in an examination room to reduce the number of times that the Reader 108 in the doctor's office attempts to authenticate a PDK 102.

Additionally, while FIG. 11A shows a proximity zone 1102 that is symmetrical, in other implementations, the proximity zone is directional. FIG. 11B shows a directional proximity zone 1104 where the Reader 108 interacts with PDKs 102a, 102b in a specific location. Hence, in FIG. 11B the Reader 108 communicates with PDKs 102a,b within the directional proximity zone 1104 and does not communicate with PDKs 102c-f outside the directional proximity zone 1104. In one embodiment, a Reader 108 has an initial configuration of a proximity zone 1102 that extends 360 degrees around the Reader; however, the Reader 108 may be modified from the initial configuration to focus the proximity zone into a directional proximity zone 1104. For example, a directional antenna may be coupled to the Reader 108 to generate a directional proximity zone 1104.

FIG. 12 illustrates an embodiment of an authentication method 1200 for the scenario where multiple PDKs 102 are present within a proximity zone 1102 or directional proximity zone 1104 of a Reader 108. In a PDK data accumulation phase 1202, PDK data 1230 is accumulated and buffered in the Reader 108 for any valid PDKs 102 that enter the proximity zone 1102 or the directional proximity zone 1104. In one embodiment, the accumulation phase 1202 begins for a PDK 102 after it has been within the proximity zone 1102, or directional proximity zone 1104, for a predetermined period of time. In one embodiment, the PDK data accumulation phase 1202 is similar to the steps 702-708 described above in detail with reference to FIG. 7 for each PDK 102a-d in the proximity zone 1102 or the directional proximity zone 1104.

As illustrated, the accumulated PDK data 1230 includes one or more differentiation metrics from each valid PDK 102 within range of the Reader 108. The differentiation metrics can include any information that can be used by the Reader 108 to determine which PDK 102 should be associated with the authentication and/or transaction request. According to

various embodiments, differentiation metrics can include one or more of distance metrics 1232, location metrics 1234 and duration metrics 1236.

In one embodiment, a distance metric 1232 indicates the relative distance of a PDK 102 to the Reader 108. This information is useful given that a PDK 102 having the shortest distance to the Reader 108 is generally more likely to be associated with a received authentication trigger (e.g., a biometric input, a PIN input or a transaction request). The distance metrics 1232 can include, for example, bit error rates, packet error rates and/or signal strength of the PDKs 102. These communication measurements can be obtained using a number of conventional techniques that will be apparent to those of ordinary skill in the art. Generally, lower error rates and high signal strength indicate the PDK 102 is closer to the Reader 108.

Location metrics 1234 can be used to determine a location of a PDK 102 and to track movement of a PDK 102 throughout an area or locate the PDK in an area. This information can be useful in determining the intent of the PDK holder to execute a transaction. For example, a PDK holder that moves in a direct path towards a cashier and then stops in the vicinity of the cashier is likely ready to make a purchase (or may be waiting in line to make a purchase). On the other hand, if the PDK 102 moves back and forth from the vicinity of a cashier, that PDK holder is likely to be browsing and not ready to make a purchase. Examples of systems for determining location metrics are described in more detail below with reference to FIGS. 13-14.

The differentiation metrics can also include duration metrics 1236 that tracks the relative duration a PDK 102 remains within the proximity zone 1102 or within the directional proximity zone 1104. Generally, the PDK 102 with the longest time duration within the proximity zone 1102, or the directional proximity zone 1104, is most likely to be associated with the authentication request. For example, if the Reader 108 is busy processing a purchasing transaction at a cashier and another PDK 102 has a long duration within the proximity zone 1102 or the directional proximity zone 1104, it is likely that the user is waiting in line to make a purchase. In one embodiment, the Reader 108 tracks duration 1236 by starting a timer associated with a PDK 102 when the PDK 102 enters the proximity zone 1102, or the directional proximity zone 1104, and resetting the time to zero when the PDK 102 exists. As another example, the Reader 108 tracks the duration when a PDK 102 of a doctor enters the proximity zone of a patient's room. A long duration of the doctor's PDK 102 within the proximity zone can provide evidence that the doctor is spending an adequate amount of time examining the patient. On the other hand, a short duration of the doctor's PDK 102 within the proximity zone can provide evidence that the doctor just merely stopped by and did not perform any thorough examination. This information is useful in monitoring patient treatment and provider performance to help ensure quality patient care.

In one embodiment, the Reader 108 can also receive and buffer profile samples 1238 prior to the start of a profile authentication instead of during the authentication process as described in FIGS. 10A-10B. In one embodiment, the Reader 108 determines which types of biometric profile samples 1238 to request based on, for example, the configuration of the Reader 108, the type of transactions performed by the Reader 108, or manual requests from a clerk, security guard, etc. In one embodiment, the PDK 102 transmits one or more of the requested sample types based on profiles available in the PDK 102 and/or user preferences.

In another embodiment, the PDK 102 transmits one or more samples 1238 it has available and only samples that match the authentication types configured for the Reader 108 are buffered. For example, if a Reader 108 is configured for fingerprint authentication, a PDK 102 may transmit samples 1238 for several different fingerprint profiles (each corresponding to a different finger, for example). It will be apparent to one of ordinary skill in the art that other variations are possible to provide flexibility in both the configuration of the Reader 108 for various types of authentication and flexibility for the PDK owner to determine which types of authentication to use.

Because profile samples 1238 only comprise a subset of the profile information, in one embodiment, the samples can be safely transmitted over a public channel without needing any encryption. In another embodiment, the profile samples 1238 are transmitted with at least some level of encryption. In yet another embodiment, some of the data is transmitted over a public communication channel and additional data is transmitted over a secure communication channel. In different configurations, other types of profile information can be accumulated in advance. For example, in one embodiment, a photograph from a picture profile can be obtained by the Reader 108 during the data accumulation phase 1202. By accumulating the profile sample 1238 or other additional information in advance, the Reader 108 can complete the authentication process more quickly because it does not wait to receive the information during authentication. This efficiency becomes increasingly important as the number of PDKs 102 within the proximity zone 1102, or within the directional proximity zone 1104, at the time of the transaction becomes larger.

The PDK accumulation phase 1202 continues until a trigger (e.g., detection of a biometric input) is detected 1204 to initiate a profile authentication process. If a biometric input is received, for example, the Reader 108 computes a mathematical representation or hash of the input that can be compared to a biometric profile and computes one or more input samples from the biometric input. It is noted that in alternative embodiments, the process can continue without any trigger. For example, in one embodiment, the transaction can be initiated when a PDK 102 reaches a predefined distance from the Reader 108 or when the PDK 102 remains within the proximity zone 1102, or within the directional proximity zone 1104, for a predetermined length of time.

The process then computes a differentiation decision 1206 to determine which PDK 102a-d should be associated with the authentication. In one embodiment, the Reader 108 computes a differentiation result for each PDK 102 using one or more of the accumulated data fields 1230. For example, in one embodiment, the differentiation result is computed as a linear combination of weighted values representing one or more of the differentiation metrics. In another embodiment, a more complex function is used. The differentiation results of each PDK 102 are compared and a PDK 102 is selected that is most likely to be associated with the transaction.

In another embodiment, for example, in a photo authentication, the differentiation decision can be made manually by a clerk, security guard, or other administrator that provides a manual input 1212. In such an embodiment, a photograph from one or more PDKs 102 within the proximity zone 1102 or within the directional proximity zone 1104 can be presented to the clerk, security guard, or other administrator on a display and he/she can select which individual to associate with the transaction. In yet another

configuration, the decision is made automatically by the Reader 108 but the clerk is given the option to override the decision.

An authentication test 1208 is initiated for the selected PDK 102. The authentication test 908 can include one or more of the methods illustrated in FIGS. 10A-10D. Note that if profile samples 1238 are acquired in advance, they need not be acquired again in the authentication steps of FIGS. 10A-10B. It is additionally noted that in one embodiment, the Reader 108 compares the profile samples 1238 of the PDKs 102 to the computed input sample until a match is found before performing a full profile comparison. In one embodiment, the Reader 108 first compares samples from the selected PDK 102 until a match is found. For example, a Reader 108 may have accumulated multiple fingerprint profiles samples 1238 (e.g., corresponding to different fingers) for the selected PDK 102. The Reader 108 receives a fingerprint input from, for example, the left index finger, computes the input sample, and does a quick comparison against the accumulated samples 1238 for the selected PDK 102 to efficiently determine a matching profile. The Reader 108 then performs the full comparison using the matching profile. In an alternative embodiment, the Reader 108 performs a comparison of a first sample from each PDK 102 and if no match is found, performs comparisons of second samples from each PDK 102. It will be apparent to one of ordinary skill in the art that samples can be compared in a variety of other orders without departing from the scope of the invention.

If the authentication test 1208 indicates a valid profile, the transaction is completed 1210 for the matching PDK 102. If the authentication test 1208 determines the profile is invalid, a new differentiation decision 1206 is made to determine the next most likely PDK 102 to be associated with the transaction. The process repeats until a valid profile is found or all the PDKs 102 are determined to be invalid.

FIG. 13 illustrates an example system is illustrated for determining a location metric 1234 of a PDK 102 using distance metrics to triangulate the location. In one embodiment of triangulation, multiple transmitting devices (e.g., Readers 108a-c) are spaced throughout an area. In one embodiment, the Readers 108a-c are coupled by a network. Each Reader 108a-c has a range 1304 and the ranges 1304 overlap. Each Reader 108a-c determines a distance D1-D3 between the Reader 108 and the PDK 102. Distance may be estimated, for example, by monitoring signal strength and/or bit error rate as previously described. Then using conventional trigonometry, an approximate location of the PDK 102 can be calculated from D1-D3. Although only three transmitters are illustrated, it will be apparent that any number of transmitters can be used to sufficiently cover a desired area. Moreover, the any number of sensors may be tied together to create an extended zone, for example, four sensors creating a "Lobby" zone. Location information can be computed at predetermined time intervals to track the movement of PDKs 102 throughout a facility. A person having ordinary skill in the art will recognize that other methods exist for determining a location metric (e.g., nearest sensor) and that one or more of these methods may be used for tracking in the same system alone or in combination. For example, triangulating provider location, using the nearest sensor method for patients, and using both nearest sensor and triangulation for locating equipment.

Another embodiment of location tracking is illustrated in FIG. 14. Here, transmitters 1402 having ranges 1404 are distributed throughout an area. The ranges 1404 can vary and can be overlapping or non-overlapping. In this embodi-

ment, each transmitter **1402** can detect when a PDK **102** enters or exists its range boundaries **1404**. By time-stamping the boundary crossings, a location vector can be determined to track the PDK's movement. For example, at a first time, t_1 , the PDK **102** is detected within the range of transmitter **1402a**. At a second time, t_2 , the PDK **102** is detected within the range of transmitter **1402b**. At a third time, t_3 , the PDK **102** is within the range of transmitter **1402c** and at a fourth time, t_4 , the PDK **102** is within the range of transmitter **1402d**. Using the location and time information, approximate motion vectors, v_1 , v_2 , v_3 , and v_4 can be computed to track the motion of the PDK **102** without necessarily computing exact distance measurements.

A person having ordinary skill in the art will recognize that the resolution of tracking or an item's location can be modified based to suit users' needs. For example, triangulation may be more accurate (better resolution) but requires more readers **108** or transmitters **1402** to create the necessary overlapping coverage than locating/tracking based on presence in a reader's **108**/transmitter's **1402** non-overlapping coverage zone

FIG. **15** is a block diagram illustrating an embodiment of a tracking server **210**. The tracking server **210** enables real-time tracking of individuals, equipment and supplies by monitoring and storing location information of individuals, equipment or supplies with associated PDKs **102**. For example, the tracking server **210** allows rapid location of healthcare providers in case of an emergency, allows monitoring of patient location to ensure timely administration of medications and allows constant monitoring of equipment or supply location to minimize search time and inventory surplus requirements. Moreover, when used in time and motion studies and reports, the tracking data may reveal areas for potential efficiency gains. For example, a time and motion study may reveal that healthcare providers walk repeatedly to a far away supply closet and by moving the supply closet or more time can be spent with patients increasing the quality of care, the number of patients a provider can examine/treat in a day or both. One embodiment of the tracking server **210** includes a location data retrieval module **1502** and a location log **1504**. In one embodiment, the location log **1504** is a database, such as a Structured Query Language (SQL) database.

In one embodiment, multiple Readers **108** are placed at certain and known positions throughout a facility. For example, a Reader is placed above each doorway of every room and at every computing device **120**. In another embodiment, Readers **108** are placed in a grid pattern throughout the facility. In one embodiment, entities within the facility carry an associated PDK **102** uniquely identifying the entity and PDKs **102** are attached to different pieces of equipment or supplies within the facility. Example embodiments of a tracking system are described in U.S. patent application Ser. No. 11/939,451 to John Giobbi, et al., entitled "Tracking System Using Personal Digital Key Groups" and filed on Nov. 13, 2007, the entire contents of which are incorporated herein by reference.

A flowchart illustrating one embodiment of a process **1600** for tracking of equipment and individuals is shown in FIG. **16A**. When a PDK **102** comes within the range of a Reader **108**, connection is authorized **1602** between the RDC **504** of the Reader **108** and the PDK **102**. In one embodiment, the RDC **504** continually transmits beacons that are detected by the PDK **102** when it enters a proximity zone of the Reader **108**. In an alternative embodiment, the communication is instead initiated by the PDK **102** and acknowledged by the Reader **108**. As shown in the previous

FIG. **7**, device authentication is first performed and once the Reader **108** establishes if the PDK **102** is a valid device and PDK **102** establishes if the Reader **108** is valid, connection can be authorized.

Once connection is authorized **1602**, the Reader **108** retrieves **1604** the PDK **102** information, such as PDK ID **312** and other information identifying the owner or entity associated with the PDK **102**. In one embodiment, the reader ID **518** of the Reader **108** is sent to the PDK **102** and stored in the activity log **390** of the PDK **102**. In one embodiment, the sensor reading (e.g., temperature readings) are also stored in the activity log allowing for temperature tracking instead of or in addition to location tracking. The reader and PDK information (including the activity log **390**) is sent **1606** to the tracking server **210**. The location data retrieval module **1502** receives **1608** the PDK information, including the PDK ID **312**. The information is updated **1610** in the location log **1604** of the tracking server **210**.

In one embodiment, the location log data is retrieved by the computing device **120**. In such embodiments, the computing device **120** displays the locations of the individuals and equipment being tracked; therefore making it possible to locate anyone and any piece of equipment at any given moment. In some embodiments, the location log data is displayed graphically, for example, with a map of the facility and indications on the map identifying locations of tracked items and people. In other embodiments, the location log data is displayed on the computing device **120** with text describing the locations of the tracked items and people.

This process **1600** occurs whenever a PDK **102** enters the proximity zone of each Reader **108** that it passes enabling constant tracking and location of individuals carrying PDKs **102** and equipment with affixed PDKs **102**.

FIG. **16B** is a graphical representation illustrating an example where patient, provider and equipment tracking is provided within a healthcare facility. Readers **1650** are located at various locations throughout the healthcare facility to receive PDK information. Computing devices are also equipped with readers **1652** for receiving PDK information. The Readers **1650** and **1652** receive information from the provider PDKs **1654**, patient PDKs **1656** and equipment PDKs **1658** enabling the location and tracking of providers, patients and equipment anywhere throughout the healthcare facility.

FIG. **17** is a block diagram illustrating an embodiment of an auto login server **220**. The auto login server **220** allows for automated electronic signing on of providers into the healthcare computer system, therefore eliminating the constant and time-consuming login and logout of healthcare providers such as doctors, nurses, physician assistants, medical technicians, and other caregivers. In one embodiment, providers can utilize their PDKs **102** to automatically log in to the application software system by simply approaching or entering the proximity zone of a Reader **620** of a computing device **120**. In such embodiments, no manual input is necessary. The auto login server **220** includes a device authentication module **1702**, a data retrieval module **1704**, a biometric authentication module **1706**, an access module **1708** and a credentials database **1710**. In some embodiments the auto login server resides in the local services module **124**. The auto login server includes input and output ports for receiving data from and sending data to one or more Readers **108**. The device authentication module **1702** is coupled to the biometric authentication module **1706** and data retrieval module **1704**. The data retrieval module **1704** is couple to communicate with the access module **1708**, which is further configured to send access authoriza-

tion to readers **620**, **108** and computing device **120**. The access module **1708** is coupled to the credentials database **1710** for comparing the received data with data stored in a credentials database **1710**.

FIG. **18** is a flowchart illustrating one embodiment of a method **1800** for automatic login of a user. When a user carrying or wearing a PDK **102** comes within the range of a Reader **620** communicating with a computing device **120**, communication is automatically established **1802** between the RDC **504** of the Reader **620** of a computing device **120**. In one embodiment, the PDK **102** is incorporated into an identification badge of the user. Once communication with the PDK **102** is established, device authentication is performed **1804**.

In one embodiment, the device authentication module **1702** performs **1804** device authentication. In another embodiment, the device authentication is performed by the Reader **108** as described in step **704** of FIG. **7**. An example embodiment of a method for performing **1804** device authentication is illustrated in the previous FIG. **8**. In one embodiment, the device authentication is performed **1804** responsive to a user accessing an application **630** for execution by the computing device **120**. For example, a user selects an application from a user bar or accesses an application **730** using the operating system of the computing device **120**.

Next, the device authentication module **1702** determines **1806** whether the PDK **102** is valid. If the PDK **102** is found to be invalid, connection is not authorized **1816** and the process ends without the logging in of the user.

In one embodiment, if the PDK **102** is found to be valid, the biometric authentication module **1706** determines **1806** if biometric information is available. If biometric information is available, the biometric authentication module **1706** performs **1810** biometric authentication. In one embodiment, a provider provides biometric information by swiping their finger on a Reader **108** of the computing device **120**. In another embodiment, the provider provides biometric information by entering a PIN number. In yet another embodiment, the provider provides biometric information by swiping their finger on the biometric reader **370** of the PDK **102**. If biometric information is not available (the provider has not swiped his finger or entered a PIN number), connection is not authorized **1820** and the process ends. If biometric information is available, biometric authentication is performed **1810**. Example embodiments for performing authentication, such as biometric authentication, are described above in conjunction with FIGS. **10A-D**.

In one embodiment, biometric authentication is performed **1810** responsive to an accessed application requesting or requiring biometric authentication. For example, responsive to a user accessing an application from an application menu of the computing device **120**, the computing device **120** determines whether a biometric check is needed by the accessed application. If a biometric check is needed by the accessed application, the computing device **120** communicates with the Reader **108** to perform **1818** biometric authentication. In one embodiment, the computing device **120** or the application server **240** includes a database specifying whether or not an application performs a biometric check.

Once biometric authentication is performed **1810**, or if biometric authentication is not needed, the data retrieval module **1704** of the registration server **205** retrieves **1812** information from the PDK **102** of the user and the access module **1708** allows **1814** the user to access one or more applications. For example, the user is allowed **1814** to access

one or more applications from the application server **240**. In some embodiments where biometric authentication is not required, the access module **1708** compares the received data with data stored in the credentials database **1710** to allow or deny access.

In one embodiment, the data retrieval module **1704** identifies a service block of a registry profile stored by the PDK **102** to the computing device **120**, which identifies the service block to the Reader **108**, which retrieves **1812** data from the identified service block. For example, the data retrieval module **1704** identifies a registry identifier to specify a service block and the Reader **108** retrieves **1812** a record identifier and a key from the service block. The Reader **108** communicates the retrieved **1812** record identifier and the key and a PDK ID to the application server **240** in addition to a request to launch the accessed application.

In one embodiment, the accessed application **630** of the computing device **120** communicates the data retrieved from the PDK **102** to the application server **240**, which communicates login credentials associated with the application **630** to the computing device **120**. The computing device **120** uses the login credential information access the application **630**. For example, the application **630** communicates a PDK ID, a record identifier and a key retrieved from the PDK **102** to the application server **240**, which identifies a login and password from the PDK ID, the record identifier and the key. The login and password are communicated from the application server **240** to the computing device **120**, which uses the login and password to launch the application **630**. In another embodiment, the application **630** of the computing device **120** retrieves the login credential information associated with the data retrieved from the PDK **102** from the credentials database **320** to allow **1814** access to one or more applications. Allowing **1814** access to one or more applications is further described below in conjunction with FIG. **19**.

In some embodiments, provider identifying information is stored in the PDK **102**. As long as connection is established (**1816—Yes**) (the provider is in the proximity zone of the reader **620** of the computing device **120**), access is allowed **1814**. If the provider steps outside the proximity zone of the reader **620**, connection is no longer established (**1816—No**) and the provider is logged out **1818** of the application server **240**. Those skilled in the art will recognize that depending on the level of authentication desired, the need for steps **1808** and **1810** may be omitted.

In some embodiments, various rules are applied. In one embodiment, biometric input is required for users who have not logged in for an extended period of time. In one embodiment, the extended period of time is eight hours. In another embodiment, the extended period of time is twenty four hours. In one embodiment, a secure screen saver is utilized in place of a full login/logout procedure. In another embodiment, the system allows for multiple users to be simultaneously logged in to a single workstation.

FIG. **19** is a flowchart of one embodiment of a method **1814** for automatically allowing access to one or more applications. Initially, it is determined **1901** whether the computing device **120** is shared or private. A shared computing device **120** is able to be automatically accessed by to users associated with a plurality of PDK IDs. A private computing device **120** is able to be automatically accessed by a user associated with a specific PDK ID. For example, a shared computing device **120** is included in a location where it is accessible by multiple users, such as in a clinic room or examination room in a healthcare facility for use by different healthcare providers, while a private computing device **120** is included in a location where its accessible by

a specific user, such as in a doctor's office of a healthcare facility for use by a specific doctor. In one embodiment, data included in the computing device 120 indicates whether the computing device 120 is shared or public.

In an alternative embodiment, rather than determine 1901 whether the computing device 120 is shared or private, the computing device 120 determines whether a user associated with the PDK 102 is a shared user or a private user. When a PDK 102 associated with a shared user communicates with a Reader 620, the computing device 120 coupled to the Reader 620 displays 1902 the user name of the user associated with the PDK 102, as further described below. Thus, if multiple PDKs 102 associated with shared users are within the proximity zone of the Reader 620, the computing device 120 communicating with the Reader 620 displays user names associated with the different shared users, and an application is not launched until one of the displayed user names is selected, as further described below. If a PDK 102 is associated with a private user, when the PDK 102 is within the proximity zone of the Reader 620, the private user is logged into 1906 the application server 240 without displaying one or more user names. Thus, when a PDK 102 associated with a private user is within the proximity zone of a Reader 620, the private user is logged into 1906 the application server 240, as further described below.

If the computing device 120 is shared, after biometric authentication is performed 1810 and the data retrieval module 1704 of the registration server 205 retrieves 1812 information from the PDK 102 of the user, the computing device 120 displays 1902 a user name associated with the information from the PDK 102. In one embodiment, if multiple PDKs 102 are within the proximity zone of the Reader 620, and the computing device 120 is shared, the computing device 120 displays 1902 user names associated with each of the PDKs 102 within the proximity zone of the Reader 620.

The computing device 120 receives 1904 an input accessing the displayed user name. If multiple user names are displayed 1902, the computing device 120 receives 1904 an input accessing one or the displayed user names. The computing device 120 or the Reader 604 then logs into 1906 the application server 240, or to the application 630, using credentials associated with the accessed user name. Using the credentials associated with the accessed user name, the computing device 120 launches 1908 one or more applications associated with the accessed user name.

For example, the application server 240 associates one or more applications with the accessed user name, and responsive to the computing device 120 receiving 1904 an access to the user name, the application server 240 communicates data to the computing device 120 to launch 1908 the one or more applications associated with the accessed user name. In one embodiment, the applications associated with the user name are stored in the application server 240 as a scenario and a user specifies a default scenario to identify applications that are automatically launched 1908 when a user is automatically logged into a computing device 120 using data stored on a PDK 102.

If the computing device 120 is private, after biometric authentication is performed 1810 and the data retrieval module 1704 of the registration server 205 retrieves 1812 information from the PDK 102 of the user, the computing device 120 or the Reader 620 then logs into 1906 the application server 240, or to the application 630, using credentials associated with the accessed user name. Using the credentials associated with the accessed user name, the computing device 120 launches 1908 one or more applica-

tions associated with the accessed user name. Hence, a private computing device 120 automatically launches 1908 one or more applications when the PDK 102 associated with a user authorized to use the private computing device 120. For example, when the PDK 102 associated with a doctor enters the proximity zone of the Reader 620 associated with a computing device 120 in the doctor's office, the computing device 120 automatically launches one or more applications associated with the doctor.

In addition to automatically launching one or more applications when a PDK 102 associated with a user is within a proximity zone of a reader coupled to a computing device 120, the auto login server 220 and/or the application server 240 allow a user to customize the one or more applications launched by the computing device 120. In some embodiments, the auto login server and/or the application server 240 also modify the one or more launched application responsive to user interaction with previously launched applications.

FIG. 20 illustrates one embodiment of a method 2000 for identifying one or more applications automatically launched for a user when the user is proximate to a Reader 620. Initially, the auto login server 220 determines whether one or more default applications are associated with a user identified from a PDK 102. A default application is automatically launched when data from a PDK 102 authenticates a user to access a computing device 120. In one embodiment, the auto login server 220 determines 2002 whether one or more default applications are associated with a user and logs in 2004 to the application server 240 using login credentials identified from the data received from the PDK 102. Alternatively, the application server 240 determines 2004 whether one or more default applications are associated with the user.

If one or more default applications are associated with a user, the application server 240 launches 2006 the one or more default applications by communicating data associated with the one or more default applications to a computing device 120 coupled to the Reader 620 from which the auto login server 220 or the application server 240 received data from the PDK 102. In one embodiment, the application server 240 applies application-specific preferences when launching 2006 a default application. For example, the application server 240 associates an application location preference with a user, so that when a default application is launched 2006 the application location preference identifies a specific location within the default application that is initially accessed. For example, the application server 240 identifies a specific text entry region of an application and when the application is launched the specified text entry region is accessed, allowing a user to begin entering text data in the specified text entry region without first selecting the text entry region. While described above in conjunction with default applications, in an embodiment the user's application specific preferences are also applied when a user manually launches an application, allowing the application server 240 to provide increased user-customization to simplify application use.

After a default application is launched 2006, a user may manually close 2012 the default application by interacting with the default application using the computing device 120. When a user manually closes 2012 a default application, the computing device 120 communicates data to the auto login server 220 and/or the application server 240 indicating that the default application has been manually closed. The auto login server 220 or the application server 240 stores 2014 data indicating that a default application has been manually

closed. In one embodiment, when a user logs out of the computing device 120 and does not exit the proximity zone of the Reader 620 coupled to the computing device 120 after manually closing the default application, the manually closed default application is not automatically launched 5 2006 when the user again logs into the computing device 120. For example, if a user logs off of the computing device 120 after manually closing a first default application and does not exit the proximity zone of the Reader 620, when the user again logs in to the computing device 120, based on the stored data, the auto login server 220 or the application server 240 does not automatically launch the first default application. However, once the user leaves the proximity zone of the Reader 620 after manually closing the first default application, once the user re-enters the proximity zone of the Reader 620 and logs into the computing device 120, the auto login server 220 or the application server 240 again automatically launches 2004 the first default application.

If a user manually closes each default application associated with the user, the application server 240 communicates data to the computing device 120 indicating that no applications are executing, causing the computing device 120 to initiate 2010 an idle state where the user is logged into the computing device 120 and to the application server 240, allowing the user to manually launch one or more applications from the computing device 120.

However, if no default applications are associated with a user, the application server 240 communicates with the computing device 120 coupled to the Reader 620 from which the auto login server 220 or the application server 240 received data from the PDK 102 to initiate 2010 an idle state. In one embodiment, the application server 240 communicates data to the computing device 120 indicating that no applications are executing, causing the computing device 120 to initiate 2010 the idle state.

The Reader 620 and PDK 102 may also be used to lock a computing device 120 coupled to the Reader 620 in addition to limiting use of the computing device 120. For example, the Reader 620 and PDK 102 may be used to limit execution of certain applications using the computing device 120 while allowing users to use other applications locally stored on the computing device 120. For example, the PDK 102 and Reader 620 are used to limit the users permitted to execute a set of healthcare applications, such as a patient record editor, while additional users may freely access a web browser included on the computing device 120. However, in some embodiments, it is desirable to further limit use of the computing device 120 so that users are unable to access applications using the computing device 120 unless a valid PDK 102 associated with the user is in the proximity zone of a Reader 620 coupled to the computing device 120.

FIG. 21 describes one embodiment of a method for locking a computing device 120 using a Reader 620 coupled to the computing device 120 and a PDK 102. In one embodiment, responsive to a PDK 120 leaving the proximity zone associated with a Reader 620, the Reader 620 communicates data to the computing device 120 and to the application server 240 to close 2104 applications currently running on the computing device 120. In one such embodiment, the data communicated from the Reader 620 to the application server 240 logs the user associated with the PDK 102 out of the application server 240. By closing 2104 applications executed by the application server 240 and by the computing device 120 when a PDK 102 leaves the proximity zone of the Reader 620, the security of the computing device 120 is increased.

Responsive to data from the Reader 620 indicating the PDK 102 has left the proximity zone of the Reader 620, after closing 2104 open applications, the computing device 120 locks 2106 its display device and initiates an access tracking process. In one embodiment, when the display device 618 is locked 2104, a predefined image is displayed on the display device 618, such as a logo or other image associated with the location where the computing device 120 is located. Alternatively, when the display device 618 is locked 2104, the display device 2104 does not display an image or is a blank screen. The access tracking process is computer-readable data stored in the storage device 608 or the memory 606 of the computing device 120 that, when executed by the processor 602, monitors the keyboard 610, the pointing device 614 or other input/output devices of the computing device 120 for inputs. In one embodiment, the access tracking process unlocks the display device 618 responsive to identifying an input received by an input/output device 120. However, until the access tracking process identifies an input received by an input/output device 120, the display 618 is locked 2104, as further described above.

In one embodiment, the computing device 120 receives 2108 one or more advertisements and displays 2110 the one or more advertisements when the display device 618 is locked rather than displaying a fixed image or blanking the display device 618. For example, the computing device 120 includes one or more advertisements in its storage device 608 and displays 2110 the one or more advertisements when the display device 618 is locked. In one embodiment, the computing device 120 alternates the advertisements displayed 2110 at different time intervals, allowing different advertisements to be displayed 2110 while the display device 618 is locked. In an alternative embodiment, the computing device 120 receives 2108 the one or more advertisements from a third party site 140 or from the application server 240 and displays 2110 one or more of the received advertisements while the display device 618 is locked 2106. In one embodiment, the application server 240 or the third party site 140 receives data from the computing device 120 and modifies the advertisements received 2108 by the computing device 120 responsive to the data received from the computing device 120. For example, the third party site 140 or the application server 240 receives data from the computing device 120 associated with a user or patient whose information has been recently accessed by the computing device 120. The computing device 120 then receives 2108 advertisements from third party site 140 or the application server 240 associated with the user or patient information. This allows the computing device 120 to display 2110 advertisements relevant to the recently accessed user or patient when the display device 618 is locked.

FIG. 22 is a graphical representation of one embodiment of automatic login of users. In this illustration, the user is a healthcare provider 2252 with a unique identifying PDK. When the healthcare provider 2252 having its associated PDK enters a patient's room and walks up to a computing device 2254, the reader of the computing device 2154 retrieves information from the provider's 2252 PDK and automatically logs the provider 2252 into the software system.

If PDKs 2256, 2258 are also used to identify the patient and equipment in the patient's room, the reader of the computing device 2254 also retrieves information from those PDKs 2256, 2258. In one embodiment, the computing device displays user names associated with the PDKs 2256, 2258 as well as a user name associated with the healthcare provider 2252 and the healthcare provider 2252 selects the

appropriate user name to log in to the computing device. One or more default applications are then launched by the computing device for access by the healthcare provider 2252.

FIG. 23 is a block diagram illustrating an embodiment of a portal server 230. The portal 230 provides a consistent interface to the third party site 140. Such services may include receiving advertisement data, accessing a patient's virtual database records or insurance information or sending prescription requests to remote pharmacies. The portal server 230 includes a remote services communication module 2302 and a remote services identifier module 2304.

FIG. 24 is a flowchart illustrating one embodiment of a method 2400 for communicating with remote services provided by a third party site 140. The remote services communication module 2302 receives 2402 a request from a computing device 120 to access one or more services, or data, provide by the third party site 140. The remote services identifier module 2304 identifies 2404 which remote service to contact. For example, if the request includes insurance information as well as payment information, the remote services identifier module 2304 determines that the request from the computing device 120 needs to be communicated to a particular third party site 140.

A determination is then made to determine whether the requested remote service or data is available 2406. If the remote service is not available (2406—No), then a connection to the third party site 140 is not established. In some embodiments, an error message is sent to the computing device 120 with a notification of the unavailability of the requested remote service. If the remote service is available (2406—Yes), communication with an appropriate third party site 140 is established.

FIG. 25 is a flow chart of one embodiment of a method 2500 initially storing data on a PDK 102 during an initialization or registration process. In the example of FIG. 25, a PDK 102 is initialized using a computing device 120. Additionally, the initial configuration and data storage of the PDK 102 is witnessed and authenticated by a specialized trusted Notary. In one embodiment, the Notary is associated with a Notary PDK. For example, the computing device 120 includes data identifying PDK IDs associated with one or more notaries.

In one embodiment, the computing device 120 initially identifies 2502 one or more Notaries to witness PDK 102 initialization. For example, a user associated with a master PDK accesses the computing device 120 and identifies one or more PDK identifiers associated with one or more Notaries. Only a user associated with the master PDK 102 is permitted to identify 2102 PDK IDs associated with one or more Notaries. For example, a user associated with a Master PDK 102 identifies one or more PDK IDs associated with Notaries, allowing the computing device 120 to locate Notaries by comparing PDK IDs from a Reader 620 to the Notary PDK IDs identified by the Master PDK.

After a Notary is identified 2502, the computing device 120 establishes 2504 communication with the PDK 102 to be initialized and establishes 2504 communication with a PDK 102 associated with a Notary, as further described above. The computing device 102 receives information from the PDK 102 to be initialized to determine if the PDK 102 to be initialized is authorized for initialization and also receives information from the PDK 102 associated with the Notary to determine if the Notary is authorized to perform the initialization. If both the PDK 102 to be initialized and the PDK 102 associated with the Notary are authorized to perform the initialization, the computing device 120

receives 2508 biometric data from a user associated with the PDK 102 to be initialized. The Notary witnesses the receipt 2508 of biometric data by the computing device 120, either in person or remotely, to ensure that the received biometric data is trustworthy. The computing device 120 then stores 2510 the received biometric data. In one embodiment, the computing device 120 communicates the biometric data to the PDK 102 to be initialized for storage and also locally stores 2510 the biometric data. In another embodiment the biometric data is stored exclusively on the PDK 102. In yet another embodiment, the computing device 120 communicates the received biometric data to a central registry 114 or a private registry 116 for storage along with the ID of the PDK 102 to be initialized. For example, the central registry 114 or a private registry 116 includes a PDK ID of the PDK 102 to be initialized, biometric data associated with the PDK ID of the PDK 102 to be initialized and other user data associated with the PDK ID of the PDK 102 to be initialized.

FIG. 26 shows an example user interface 2600 for configuring user information associated with a PDK 102. In one embodiment, the user interface 2600 is displayed by a computing device 120 that is used to initialize a PDK 102. The user interface 2600 includes a user configuration region having a user identifier editor 2602, a user type editor 2604 and a PDK ID editor 2606. Interacting with the user identifier editor 2602, the user type editor 2604 and the PDK ID editor 2606 allows a user, such as an administrator, to specify a user identifier associated with a PDK ID and to associate a user type with the user name and with the associated PDK ID. In one embodiment, the user type editor 2604 allows a user to select from a predefined listing of user types. For example, the user type editor 2604 allows a user to specify whether a user identifier is associated with a general user, with an administrator or with a Notary. Depending on the user type, the functionality of a user is modified. For example, a user identifier associated with an administrator is able to modify execution of different applications or customize application execution for other users while a user identifier associated with a Notary is authorized to authenticate the accuracy of biometric data received by the computing device 120.

Additionally, the user interface 2600 includes a user data summary 2610 that displays data associated with a user identifier, such as contact information for the user, a job title for the user and a listing of groups to which the user belongs. In one embodiment, a user accesses the user data summary 2610 to identify one or more groups to which the user belongs. Depending upon the embodiment, a user or asset's group(s) can be automatically or manually assigned. In one embodiment, a user or asset's group membership determines one or more of the asset or user's general use processes, typical setup and search processes, default alert conditions. Grouping dramatically simplifies and speeds-up the setup procedure for a user or asset's PDK. A biometric data summary 2608 is also displayed to identify the type of biometric data associated with a user and allowing a Notary to modify the biometric data by interacting with the biometric data summary. For example, a Notary may access the biometric data summary 2608 to obtain a different type of biometric data associated with the user.

FIG. 27 shows an example user interface 2700 for configuring asset information associated with a PDK 102. While FIG. 26 describes configuration of a user, such as an individual, associated with a PDK 102, FIG. 27 describes configuration of information associated with an asset, such as equipment or supplies, associated with a PDK 102. In one embodiment, the user interface 2700 is displayed by a

computing device **120** that is used to initialize a PDK **102**. The user interface **2700** includes an asset configuration region having an asset identifier editor **2702**, an asset type editor **2704** and a PDK ID editor **2706**. Interacting with the asset identifier editor **2702**, the asset type editor **2704** and the PDK ID editor **2706** allows a user, such as an administrator, to specify a user identifier associated with a PDK ID and to associate a user type with the user name and with the associated PDK ID. In one embodiment, the asset type editor **2704** allows a user to select from a predefined listing of asset types. For example, the asset type editor **2704** allows a user to specify whether an asset identifier is associated with a general asset, with an administrator or with a Notary. Depending on the asset type, the functionality of an asset is modified, as described above in conjunction with FIG. **26**.

Additionally, the user interface **2700** includes an asset data summary **2708** that displays data associated with an asset identifier, such as an asset name, an asset description, an asset location, an asset category, an asset service data or other data describing attributes of the asset. In one embodiment, a user accesses the asset data summary **2708** to identify one or more groups to which the asset belongs.

In addition to interacting with a user data summary **2610** or an asset data summary **2708** to associate users or assets with a group, one or more user interfaces may be used to automatically or manually associate user identifiers or asset identifiers with one or more groups. FIG. **28** illustrates an example user interface **2800** allowing a user to manually identify members, such as users and/or assets, included in a group. The user interface **2800** includes a group description **2802** allowing a user to identify a group type, specify a group name and to modify the group name or group type.

A member selection region **2804** identifies users and/or assets included in a central registry **114** and/or a private registry **116** using a user listing **2806** and identifies users and/or assets included in the group identified by the group description **2802** using a member listing **2808**. In one embodiment, a user selects a user identifier, or an asset identifier, from the user listing **2806** and accesses a group modification region **2810**, causing the selected user identifier or asset identifier to be included in the group identified by the group description **2802**. Once the group modification region **2810** is accessed, the selected group identifier, or asset identifier, is displayed in the member listing **2808** rather than in the user listing **2806**. Similarly, a user selects a user identifier, or an asset identifier, from the member listing **2808** and accesses a group modification region **2810** to remove the selected user identifier, or asset identifier, from the group identified by the group description **2802**.

FIG. **29** illustrates an example user interface **2900** allowing a user to automatically include users and/or assets in a group based on one or more criteria. The user interface **2900** includes a group description **2802** allowing a user to identify a group type, specify a group name and to modify the group name or group type.

A rule specification region **2904** receives input identifying one or more rules for identifying users and/or assets for inclusion in a group. For example, the rule specification region **2904** receives rules for including a user or asset in the group identified by the group description **2802**. In one embodiment, the rule specification region **2904** receives input identifying values for one or more fields associated with a user, or an asset, and a user or asset including fields matching the values identified by the rules is automatically associated with the group identified in the group description **2802**. In the example shown by FIG. **29**, the rule specification region **2904** allows a user to specify combinations of

fields and values associated with the fields to customize the users or assets included in the group. For example, a rule may include logical operators, such as "AND" or "OR," to describe combinations of values and/or fields.

FIG. **30** is an example of a user interface **3000** for tracking a user or asset associated with a PDK **102** from a computing device **120**. The user interface **3000** receives input from a user to identify a user or asset to be tracked by the tracking server **210**. In the example of FIG. **30**, the user interface **3000** includes a quick search interface **3002** and an advanced search interface **3004** as well as a result listing **3006**.

A person having ordinary skill will recognize that the search options for the quick search **3002** and advanced search **3004** interfaces can range from pre-defined named criteria selection, to common filters related to the tracked item type, to detailed multi-level equation-based tracked item value field specifications.

The quick search interface **3002** receives input from a user for performing simple searches based on a limited amount of data associated with a user or an asset. For example, the quick search interface **3002** receives input identifying a name, a title, a description or a location of a user or an asset and identifies the user or asset matching the received input. The quick search interface **3002** also allows specification of a group identifier to retrieve assets or users included in the specified group.

The advanced search interface **3004** receives input for performing advanced searches based on multiple data associated with a user or an asset or based on combinations of data associated with a user or an asset. In one embodiment, the advanced search interface **3004** receives input identifying values for one or more fields associated with a user or an asset that are used to identify one or more users or assets including fields having values matching those identified by the values, or combination of values, received by the advanced search interface **3004**. In the example shown by FIG. **30**, the advanced search interface **3004** allows a user to specify combinations of fields and values associated with the fields to identify assets or values. For example, the advanced search interface **3004** receives input identifying values for multiple fields and logical operators describing a number of values for different fields. For example, the advanced search interface **3004** allows values for fields to be combined using logical operators, such as "AND" or "OR," to describe combinations of values and/or fields.

The result listing **3006** displays data associated with users or assets that match the search criteria received by the quick search interface **3002** or the advanced search interface **3004**. In one embodiment, the results listing **3006** dynamic, i.e., the results are dynamically modified and displayed as a user inputs or modifies search criteria enabling the user to review and accept or continue entry of criteria. For example, in such an embodiment, if the user is searching for a heart monitor on a specific floor of a hospital, the user inputs or selects "heart monitor" in a name or description field causing all heart monitors in the system to be displayed in the results listing **3006**. The user then scrolls through the floorplan options in a floorplan drop-down menu. As the user mouses-over each floorplan the heart rate monitors located on the moused-over floorplan are automatically displayed in the result listing **3006** without the user selecting the floorplan. For example, the result listing **3006** displays a name, a title, a description, a floorplan and a location associated with different assets or users matching the search criteria. In one embodiment, the result listing **3006** receives input selecting one or more of the search results and a tracking input **3008**

41

causes the tracking server **210** to monitor the location of the assets or users selected via the result listing **3006**. In one embodiment, a first input received by the tracking input **3008** causes the tracking server **210** to track the selected assets or users while a second input received by the tracking input **3010** causes the tracking server **210** to track each of the assets or users identified by the result listing **3006**. In one embodiment, a third input **3012** causes the tracking server to generate a report and a fourth input (not shown) causes the tracking server to generate an alarm regarding one or more of the users or assets in the result listing **3006**. The search results and/or subsequent locations, tracking, or reports can be displayed in any number of forms including, but not limited to textually, graphically or in time and motion study reports,

FIG. **31** is an example of a user interface **3100** for identifying the location of a tracked user or asset associated with a PDK **102** from a computing device **120**. The user interface **3100** displays data from the tracking server **210** indicating the location of one or more assets or users tracked by the tracking server **210**. In the example of FIG. **30**, the user interface **3100** includes a tracked item listing **3102**, a navigation interface **3104**, an item location selector **3106** and a primary item selector **3108**.

The tracked item listing **3102** displays an item identifier associated with users or assets tracked by the tracking server **210**. For example, the tracked item listing **3102** displays a user name or asset name associated with the tracked items. The tracked items list **3102** can include selected items from a single or most recent search result or can accumulate items from a plurality of search results. In one embodiment, the tracked item listing **3102** receives input selecting a user or asset and a subsequent input received by the item location selector **3106** or the primary item selector **3108** modifies the user interface **310**. Items included in the tracked item listing **3102** may be manually identified by user input or may be automatically included based on one or more criteria of a user or an asset.

After selecting a user or asset from the tracked item listing **3102**, an input received by the item location selector **3106** causes the user interface **3100** to visually distinguish the location of the selected item in the navigation interface **3104**. For example, the navigation interface **3104** visually distinguishes the selected item from other tracked items responsive to the item location selector **3106** thus making the item easier to find on a crowded display. In the example of FIG. **31**, the navigation interface **3104** modifies the color used to display the selected item and displays rings around the selected item responsive to the item location selector **3106** receiving an input. In one embodiment, tracking is in or near real-time or periodically updated (e.g., a every few minutes). In one embodiment, historic tracking is possible, i.e., showing the item's change in location and time intervals of location change or being able to playback the items route over a time interval. In one embodiment, the historic tracking is utilized for time and motion reports and/or study, which includes one or more textual reports for any combination of tracked items and site map tracking zones and time periods including relative time periods (e.g., yesterday, last night, etc.) showing various formats of tracking time and location data. In one embodiment, the historic tracking data capable of being output for external playback or recording.

After selecting a user or asset from the tracked item listing **3102**, an input received by the primary item selector **3108** causes the user interface **3100** to make the selected item the primary item so that the navigation interface **3104** is modified to keep the selected item visible. For example, the

42

navigation interface **3104** scrolls as the primary item moves (even between floorplans) to keep the primary item visible in the navigation interface **3104**. Additionally, the navigation interface **3104** may visually differentiate the primary item from other tracked items by changing the color used to display the primary item or otherwise modifying the presentation of the primary item relative to other tracked items. In one embodiment, other items near the primary item are displayed. This may be important for reducing response times. For example, a heart monitor detects heart failure and alert is sent to the nearest provider. In one embodiment, the user may select a tracked item using a pointing device **614** to display information regarding the item, e.g., the item's ID, tracking data, or reference data.

The navigation interface **3104** displays the location of the items identified in the tracked item listing **3102** in a graphical representation of the environment including the tracked items. For example, the navigation interface **3104** displays a floorplan of an environment including the tracked items with the location of the tracked items overlaid on the floorplan. In one embodiment, the navigation interface **3104** includes navigation controls allowing a user to zoom in or out of the graphical representation of the environment including the tracked items or to pan across the graphical representation of the environment including the tracked items. In one embodiment, the navigation interface **3104** displays the current location (not shown) of the user and/or the computing device **120** the user is using to track the items from in addition to the one or more items the user desires to track. In one such embodiment, the navigation interface **3104** includes an auto navigate function which will automatically pan or zoom to the user's location or the tracked item's location. In one embodiment, the navigation interface **3104** will also display a route the user can take to reach the tracked item. The navigation interface **3104** may also include a selector allowing modification of the graphical representation of the environment including the tracked items. For example, the navigation interface **3104** allows modification of the floorplan on which the positions of the tracked items are overlaid.

In one embodiment, the navigation interface **3104** also displays one or more alert notifications **3110** associated with tracked items. An alert notification **3110** is displayed responsive to a tracked item meeting one or more criteria. The one or more criteria can include a particular PDK **102** or event being detected (e.g., psychiatric patient leaves the psychiatric ward or enters a restricted zone, a minimum or maximum number of qualified PDKs entering or leaving a zone, or paired PDKs **102** being separated) or not being detected (e.g., a doctor not making rounds) including sudden or unexpected detection or loss of detection (e.g., loss of signal without low battery warning), which may indicate PDK **102** or system malfunction (e.g., a broken PDK) or tampering (e.g., a person hiding the signal by covering the PDK with metal or otherwise disabling the device, one or more sensor readings (e.g., temperature proximate to an asset enters or exits a user specified range or a low battery is detected) or at a predetermined time (e.g., when an asset must be serviced, calibrated or decommissioned). The alert notification **3110** visually differentiates the item meeting the criteria from other tracked items. In one embodiment, the alert notification **3110** displays a text message describing the alert. In one embodiment, one or more alerts may be temporarily disabled for a brief period of time by selecting a "reset in process" status. In one embodiment, one or more of the type of alert, frequency of alert, response time to alert and user responding to an alert are logged and available for review and analysis. A user interface, such as the one

described below in conjunction with FIG. 32, allows customization of the criteria that cause display of an alert notification 3110.

FIG. 32 is an example of a user interface 3200 for specifying generation of an alert for an asset or user tracked by the tracking server 210. The user interface 3200 includes a current alert listing 3202 and an alert editor 3204. In one embodiment, data received by the user interface 3200 is communicated to the alert server 250, which generates alerts responsive to the received data. The current alert listing 3202 identifies alerts which are applied by the alert server 250 to data received from the tracking server 210 and/or from one or more PDKs 102. For example, the current alert listing 3202 displays an alert identifier and a description of the alerts currently being monitored by the alert server 250. The alerts in the current alert listing 3202 may be monitored simultaneously, randomly or in a preconfigured priority order. The current alert listing 3202 also receives input stopping the alert server 250 from applying an alert to received data. Also, the current alert listing 3202 receives input for creating a new alert for application by the alert server 250.

The alert editor 3204 receives input for specifying a new alert or for modifying attributes of an existing alert. For example, the alert editor 3204 receives data identifying the source of data for which the alert server 250 applies the alert, such as from the tracking server 210, from a PDK 102 or from a Reader 108 or other sensor. The alert editor 3204 also receives data specifying the criteria causing an alert to be generated. For example, the alert editor 3204 receives data specifying a temperature range so that an alert is generated when the alert server 250 receives data from a source indicating the temperature is within the specified range.

The alert editor 3204 also receives data specifying how the alert server 250 notifies a user that an alert is generated. In one embodiment, the alert editor 3204 receives data identifying one or more communication protocols and contact information used to communicate an alert notification to a user. For example, the alert editor 3204 receives a user telephone number and e-mail address associated with a user, allowing the user to receive notification of an alert via a telephone call, a text message and/or an e-mail. In one embodiment, the alert editor 3204 associates a priority level to be associated with different communication protocols to allow a user to specify how the user is notified when an alert is generated. For example, the alert editor 3204 associates a first communication protocol with a first priority level and if the tracking server 210 does not receive a response within a specified time interval after notifying a user of an alert, a second communication protocol having a second priority level is used to again notify the user of the alert.

FIG. 33 is an example of a user interface 3300 for describing reports generated by data received from the tracking server 210 describing movement of assets or users. The user interface 3300 includes a current report listing 3302 and a report editor 3304. The current report listing 3302 identifies reports which are generated by the tracking server 210 based on data received from PDKs 102 or other sources. For example, the current report listing 3302 displays a report identifier and a description of the reports being generated by the tracking server 210. The current report listing 3302 also receives input stopping the generation of a report by the tracking server 210 from received data. Also, the current report listing 3302 receives input for creating a new report for generation by the tracking server 210 or for editing a report generated by the tracking server 210.

The report editor 3304 receives input for specifying a new report for generation or for modifying a currently generated report. For example, the report editor 3304 receives data identifying a type of report, a PDK 102 from which data for the report is received, one or more locations from which data included in the report is received, a time interval associated with the report and a description of data included in the generated report. For example, the report editor 3304 receives data indicating that the report includes the number of PDKs 102 visiting a location, the total number of locations visited by a PDK 102, the length of time a PDK 102 was in a location or other suitable data. In one embodiment, the report editor 3304 also receives data describing how the content included in the report is presented.

The foregoing description of the embodiments of the present embodiment of invention has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the present embodiment of invention to the precise form disclosed. Many modifications and variations are possible in light of the above teaching. It is intended that the scope of the present embodiment of invention be limited not by this detailed description, but rather by the claims of this application. As will be understood by those familiar with the art, the present embodiment of invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. Likewise, the particular naming and division of the modules, routines, features, attributes, methodologies and other aspects are not mandatory or significant, and the mechanisms that implement the present embodiment of invention or its features may have different names, divisions and/or formats. Furthermore, as will be apparent to one of ordinary skill in the relevant art, the modules, routines, features, attributes, methodologies and other aspects of the present embodiment of invention can be implemented as software, hardware, firmware or any combination of the three. Also, wherever a component, an example of which is a module, of the present embodiment of invention is implemented as software, the component can be implemented as a standalone program, as part of a larger program, as a plurality of separate programs, as a statically or dynamically linked library, as a kernel loadable module, as a device driver, and/or in every and any other way known now or in the future to those of ordinary skill in the art of computer programming. Additionally, the present embodiment of invention is in no way limited to implementation in any specific programming language, or for any specific operating system or environment. Accordingly, the disclosure of the present embodiment of invention is intended to be illustrative, but not limiting, of the scope of the present embodiment of invention, which is set forth in the following claims.

What is claimed is:

1. A system comprising:

- a first personal digital key (PDK) including a profile uniquely associated with a first entity, the first PDK associated with a group during configuration, the group acting as a potential search criterion and expediting the configuration by indicating one or more settings associated with the group with which the first PDK is associated; and
- a computing device configured to receive the group as a search criterion and display a graphical representation of a location of the first PDK associated with the first entity, wherein the graphical representation includes a location of a second PDK of a second entity, the second

45

PDK not associated with the group, and wherein the graphical representation of the first PDK and the second PDK is distinct.

2. The system of claim 1, wherein the first entity is one of a first object and a first user, and the second entity is one of a second object and a second user.

3. The system of claim 2, wherein the graphical representation includes a graphical representation of a location of a third entity associated with the received search criterion.

4. The system of claim 1, wherein the computing device is further configured to display a search interface to receive the search criterion, and to display a result set of one or more entities that satisfy the search criterion, the result set of one or more entities including the first entity associated with the first PDK.

5. The system of claim 1, further comprising:
an alert server, the alert server configured to automatically provide updates and alerts for monitored entities.

6. The system of claim 5, wherein the alert server is further configured to receive data from an alert editor, wherein the data received from the alert editor includes an alert identifier and entity associated with the alert identifier.

7. The system of claim 5, wherein in response to the alert server receiving information indicating that a monitored PDK, or sensor data associated with the monitored PDK, is outside a predefined range, or has entered the predefined range, or that the monitored PDK is unexpectedly detected or not detected, the alert server further configured to generate an alert.

8. The system of claim 5, wherein an alert creates a response at a monitored entity, wherein the response identifies one or more of the monitored entity associated with the alert and a type of alert.

9. The system of claim 5, wherein the graphical representation includes the location of the first PDK associated with the first entity on a floorplan of a monitored area when the first PDK is detected within a predefined range of the second PDK, responsive to an alert associated with the second PDK.

10. The system of claim 1, wherein the graphical representation of the location of the first PDK associated with the first entity is displayed in real-time on one or more floor plans and the graphical representation is updated to continuously display the location of the first PDK associated with the first entity as the first PDK associated with the first entity changes location or moves between floorplans.

11. The system of claim 1, wherein the graphical representation of the location of the first PDK associated with the first entity includes historical location information associated with the first PDK associated with the first entity.

12. A method comprising:
receiving a search query including one or more search criterion associated with a first personal digital key (PDK), the first PDK associated with a first entity, the first PDK associated with a group during configuration,

46

the association with the group acting as a potential search criterion and the association with the group expediting the configuration by indicating one or more settings associated with the group with which the first PDK is associated;

receiving information indicating a location of the first PDK, the first PDK associated with the first entity; and generating a graphical representation of the location of the first PDK associated with the first entity, wherein the graphical representation includes a location of a second PDK of a second entity, the second PDK not associated with the group, and wherein the graphical representation of the first PDK and the second PDK is distinct.

13. The method of claim 12, further comprising:
generating a search interface for receiving the search query, wherein the search query includes the group as the search criterion.

14. The method of claim 12, further comprising:
monitoring information associated with one or more monitored PDKs including the first PDK; and providing at least one from a group of an alert and an alarm.

15. The method of claim 14, wherein at least one from the group of the alert and the alarm is provided in response to receiving information indicating that a monitored PDK, or sensor data associated with the monitored PDK, is outside a predefined range, or has entered the predefined range, or that the monitored PDK is unexpectedly detected or not detected.

16. The method of claim 14, further comprising:
creating a response at a monitored entity to help identify the monitored entity associated with the alert or alarm, a type of alert or alarm, or both.

17. The method of claim 14, wherein generated graphical representation includes the location of the first PDK associated with the first entity on a floorplan of a monitored area when the first PDK is detected within a predefined range of a second PDK, responsive to an alert associated with the second PDK.

18. The method of claim 12, wherein the generated graphical representation of the location of the first PDK associated with the first entity is displayed in real-time on one or more floor plans and the graphical representation is updated to continuously display a graphical representation of the location of the first PDK associated with the first entity as the first PDK associated with the first entity changes location or moves between floorplans.

19. The method of claim 12, wherein the first entity is one of a first object and a first user, and the second entity is one of a second object and a second user.

20. The method of claim 12, wherein the generated graphical representation includes historical location information associated with the first PDK associated with the first entity.

* * * * *